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ABSTRACT

This thesis provides evidence for the existence of a creativity dimension containing figural and verbal subfactors which is independent of intelligence and marginally related to school achievement. The original data of Wallach and Kogan, as well as the data from the Ward, Cropley and Maslany and Wallach and Wing studies were reanalyzed using Joreskog's Unrestricted Maximum Likelihood Factor Analysis (UMLFA). In addition, three of the Guilford studies and the Getzels and Jackson 1962 study on creativity and intelligence were reanalyzed using the UMLFA technique. These reanalyses provided clear evidence not only for the distinct creativity and intelligence dimensions but also for figural and verbal subfactors in the creativity dimension. The Wallach and Kogan materials were used in an original research study with secondary school students in Brooklyn, New York. The two-factor structure of the creativity dimension was clearly verified, and the creativity measures were related to many more common measures of intelligence than have been reported. The creativity and intelligence measures were related to actual school grades in science, math, English, and social studies. Three factors clearly related to creativity, intelligence, and school achievement were identified. The independence of creativity and intelligence was verified, and a marginal relationship between creativity and school grades was indicated. Multiple regression analyses confirmed the conclusions. (Author/KM)

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Richard T. Murphy

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In 1965, Wallach and Kogan (1965a) published the results of their research on creativity in the text Modes of Thinking in Young Children. They studied a group of children with a mean age of 10 years, 8 months using materials on creativity which have come to be referred to in the literature as the Wallach and Kogan tests of creativity. They provided evidence for the existence of a creativity dimension distinct from intelligence.

Since 1965, William Ward (ETS), Cropley and Maslany (University of Saskatchewan), and Wallach and Wing (Duke University) have administered the Wallach and Kogan materials to elementary school children and to college students. They corroborated, with varying degrees of success, the Wallach and Kogan hypothesis.

In this thesis, the original data of Wallach and Kogan, as well as the data from the Ward, Cropley and Maslany, and Wallach and Wing studies are reanalyzed using Jöreskög's Unrestricted Maximum Likelihood Factor Analysis (UMLFA). In addition,

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13. Abstract (Continued)

three of the Guilford studies and the Getzels and Jackson 1962 study on creativity and intelligence have been reanalyzed using the UMLFA technique. These reanalyses provide clear evidence not only for the distinct creativity and intelligence dimensions but also for figural and verbal subfactors in the creativity dimension. In some cases, the previous data were not factor analyzed. In these cases, the UMLFA technique provides clear evidence for subfactors. In cases where the data were previously factor analyzed, the UMLFA technique provides for a clearer interpretation of the data. The difference between this unrestricted maximum likelihood technique and other factor techniques is that this technique is developed on the basis of underlying normally distributed variables and the existence of a likelihood function that is minimized.

In addition to these reanalyses, the Wallach and Kogan materials were used in an original research study with secondary school students from a large high school in Brooklyn, New York. The two-factor structure of the creativity dimension was clearly verified. In addition, the creativity measures were related to many more common measures of intelligence than have been reported in studies thus far. Also, the creativity and intelligence measures were related to actual school grades in science, mathematics, English, and social studies. Three factors clearly related to creativity, intelligence, and school achievement were identified using the UMLFA technique. The figural and verbal subfactors in the creativity dimension were also clearly identified. The independence of the creativity and intelligence dimensions was verified, and a marginal relationship between creativity and school grades was indicated in the factor structure. To further verify this final indication, indices of creativity, intelligence, and school achievement were developed. The school achievement index was then used as the dependent variable in a multiple regression with creativity and intelligence as independent variables. The regression was carried out with each variable alone, with both jointly, and in stepwise progression with intelligence first and creativity second. The conclusions indicated in the factor structure were confirmed in each case.

In summary, then, this thesis provides rather good evidence for the existence of a creativity dimension containing figural and verbal subfactors which is independent from intelligence and marginally related to school achievement. This evidence was obtained by reanalyzing the data from previous studies and by an original research study with high school students.

INVESTIGATION OF A CREATIVITY DIMENSION

by

Richard T. Murphy

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In this thesis, the original data of Wallach and Kogan, as well as the data from the Ward, Cropley and Maslany, and Wallach and Wing studies are reanalyzed using Jöreskog's Unrestricted Maximum Likelihood Factor Analysis (UMLFA). In addition, three of the Guilford studies and the Getzels and Jackson 1962 study on creativity and intelligence have been reanalyzed using the UMLFA technique. These reanalyses provide clear evidence not only for the distinct creativity and intelligence dimensions but also for figural and verbal subfactors in the creativity dimension. In some cases, the previous

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FOREWORD

The primary challenge facing the factor theorist in psychology is to identify those underlying factors which explain or at least account for varying amounts of human behavior. To be useful, the factors must be neither too general nor too specific. The history of the development of the intelligence factor seems to indicate that a fruitful way to proceed is to identify an underlying factor that is somewhat general and then to examine its substructure. It was by showing that intelligence was not a unitary factor that Thurstone developed his primary mental abilities. These primary mental abilities have proved useful in studying human behavior, especially behavior related to the process of education. Using school grades as a measure of "success," the primary mental abilities have predicted success rather well.

Measures of success have changed radically in the last decade. Emphasis on grades has decreased. Many courses in college are now offered on a pass-fail basis. Many high schools are offering expanded programs of elective courses in which motivation and interest are as important prerequisites as intellectual ability. The educational system in general is becoming much more complex, and this complexity is probably a natural outgrowth of advances in psychology and education which have led to a better understanding of the individual differences among children and a better appreciation of the possibilities for a more total development of the student's personality. The recognition of complexity in the individual and the concurrent success in developing devices to identify and measure the many facets of the individual will naturally result in a more complicated model of a student than that

provided by one intelligence measure. Indeed, the inadequacy of a monolithic intelligence as the underlying factor of much of human behavior has long been recognized, and much research has attempted to identify other underlying factors in order to provide a more complete picture.

One area of development that has received much attention during the recent past is that of "creativity." Naturally, there is disagreement about what creativity really is. This should not be surprising. Psychologists have been measuring intelligence for years without knowing what it really is. In fact, L. L. Thurstone presented a paper in 1950 on creative talent in which he pointed out that we may discover how to select people with creative talent before we learn much about the nature of that kind of talent. Nevertheless, even the gross variable of intelligence has been very useful. Knowledge of its substructure has increased its usefulness. Some researchers now believe that there is sufficient evidence for the existence of a creativity dimension, a dimension on which individuals will differ when measured appropriately. In addition, some researchers claim that this dimension will be distinct from intelligence. These claims will be examined in this thesis.

Assuming that it could be done, what value would there be in identifying such a dimension? It may very well be on this dimension that current changes in education have their greatest effects. Since 1957, with the impetus provided by Russia's successful launching of Sputnik I, goals and methods of education in the United States have undergone significant changes. The goal of learning the specific facts in a discipline has been replaced by the goal of learning to understand the structure of the discipline. New methods include independent study, group discussion, field work, and student discovery.

Thus, for more than ten years some schools have been trying to develop a student who differs in several important ways from the pre-1957 student. How is this new student to be evaluated? If new goals have been set and new methods are being used, then perhaps new measuring instruments are needed to evaluate whether the methods are successful and whether the goals are reached. The students profiting from such an education might be more independent, more flexible, more articulate, and more original. The tests involved in creativity testing might be involved with factors underlying such human behaviors. At any rate, the attempt to identify and delineate such a factor seems to be a worthwhile undertaking.

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LIST OF TABLES AND FIGURFS

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CHAPTER 1

SURVEY OF THE CREATIVITY TESTING RESEARCH

1.1 Introduction

It is rather important at the beginning to limit the range of the discussion. Creativity is a very broad area. There are many books and articles which deal with it. Excellent and extensive surveys of the literature can be found in Stein and Heinze, 1960; C. W. Taylor, 1964a; and Stein's recent chapter in the Handbook of Personality Theory and Research, 1969.

In this thesis, the primary concern will be with testing for creativity. Specifically, the attempt will be made to justify and give a theoretical basis for the particular tests used by Michael Wallach and Nathan Kogan in their research study which was eventually published in the book Modes of Thinking in Young Children (1965a). In order to do this most convincingly, it will be helpful to examine a number of studies that preceded the Wallach and Kogan study.

1.2 J. P. Guilford and the Aptitudes Research Project

On September 3, 1950, Guilford presented his presidential address entitled Creativity to the American Psychological Association. That speech is generally recognized as having signaled the beginning of a new era in the study of creativity. Indeed, it signaled the beginning of Guilford's own research which has spanned two decades and has influenced almost all other researchers in creativity testing. Guilford outlined a plan for a comprehensive assault on the area of creativity using a variety of measuring

devices and the techniques of factor analysis. On December 31, 1969, after .aving performed 36 major factor analyses, published 41 technical reports, claimed the identification of some 98 unique abilities, and devised numerous measuring instruments, Guilford and his associates at the Aptitudes Research Project published their final report.

Guilford began his work by attempting to discover hitherto unknown intellectual factors along the line of the Thurstone mental abilities. In his 1950 paper, he had hypothesized that creative thinking would include such factors as sensitivity to problems, ideational fluency, flexibility of set, ideational novelty, synthesizing ability, analyzing ability, reorganizing or redefining ability, span of ideational structure, and evaluating ability. Definitions of these factors can be found in Guilford's general summary of 1969. Guilford devised tests to measure these and various other factors. Eventually, as more and more factors became identified, Guilford began to construct a general theory of factors, the structure-of-intellect theory, which included 120 separate factors. The model for this theory is well known, a three dimensional rectangular parallelepiped with dimensions corresponding to various contents, operations, and products. Greater detail can be found in Guilford's The Nature of Human Intelligence, 1967.

The important consideration for this thesis is whether or not Guilford has succeeded in identifying by his various tests a dimension which can be fairly called creativity and which is distinct from intelligence. Guilford claims that he has. Others (Q. McNemar, 1964; R. L. Thorndike, 1962; Wallach & Kogan, 1965a) claim that he has not. The difficulty lies in the fact that Guilford's factor studies contain numerous variables, numerous tests, and

numerous factors. His theory of creativity has evolved into selecting a certain subset of the 120 factors in his model to account for creative thinking. These include primarily his divergent thinking factors. In studies using these factors, Guilford does not include a measure of general intelligence. Quinn McNemar, in his presidential address to the American Psychological Association in 1964, scored Guilford rather harshly for this omission.

> Does the failure to include an IQ test help one learn the extent to which one must go beyond the boundaries of the IQ (this refers to one of the aims that Guilford had set in his 1950 address) to fathom creativity? Apparently the author (Guilford), although willing to predict that the correlations between IQ and the many types of creativity tests "are only moderate or low," was unwilling to include an IQ test for the sake of finding out. However, negation by omission is not very convincing.

R. L. Thorndike (1962) has also attempted to shed some light on this difficulty of identifying a creativity dimension.

> We may appropriately ask how well the attribute "creativity" meets these joint criteria of designating a reasonably extensive set of behaviors which (1) have some degree of coherence and (2) can be distinguished from other sets of behaviors.

And more specifically for the domain of testing,

> In the test domain, as distinct from the life activities domain, the question as to the meaningfulness of a general rubric of "creativity" can be raised somewhat more incisively. We may ask whether there is a variety of different test behaviors that (1) seem reasonably to pertain to the concept of "creativity," (2) are associated so that a person who tends to exhibit one also tends to exhibit the other, and (3) are distinct from other sets of test behaviors such as the set to which we have applied the term "abstract intelligence."

Thorndike makes a good analogy to the domain of intelligence to clarify this point further.

The essential points are that although there is a degree of specialization of intellectual functioning, so that two tests within a specific region of content or process correlate more highly than those from different regions, still the correlations across regions are appreciably positive. It is these uniformly positive correlations, whether conceptualized as G, or a second-order factor among the primary factors, or as an overlapping of group factors, that give some substance to the general concept of abstract intelligence and some reasonableness to pooling a set of subtests into a common score.

We may appropriately ask whether there is another broad second-order factor in the test domain, distinct from the traditional G, to which the term "creativity" can be appropriately applied. The existence of such a distinct factor is strongly implied in the publications by Getzels and Jackson and by Torrance, among others, and Guilford and his associates have fairly sharply differentiated between tests of convergent and divergent thinking. How well does this differentiation of two broad cognitive domains hold up in practice?

I have reanalyzed some of the published data to try to get a partial answer to these questions.

In reanalyzing the Guilford data, Thorndike used the following technique. He classified the various factors as "old-line or convergent thinking factors" or as "new-type divergent thinking (i.e., creativity) factors." He then selected the two tests which loaded highest on each of the factors to represent that factor. He then prepared correlation matrices including only these tests. Using this reduced correlation matrix, he determined the average correlation of each test with the other "convergent" tests and with the other "divergent" tests. He used these correlations as indications of the extent to which a test is related to the tests in its own domain and the extent to which it is related to the tests in the other domain.

Thorndike applied this technique to two batteries of the Guilford tests reported in the technical reports of the Aptitudes Research Project. In the

first reanalysis, Thorndike reported an average correlation of .23 among the "convergent" tests, of .14 among the "divergent" tests, and an average correlation of .12 between the two sets of tests. In the second reanalysis, the corresponding correlations were .43, .27, and .24. Wallach and Kogan conclude from this that "the general intelligence procedures are more highly related among themselves than the divergent thinking procedures, and the divergent thinking procedures are almost as strongly related to the general intelligence indicators as the divergent thinking procedures are related among themselves," and that "most of what unites the divergent thinking measures is the variance they have in common with the indicators of general intelligence."

Although this conclusion of Wallach and Kogan may be true, it is not warranted by the Thorndike reanalyses. Average correlations do not indicate the existence of factors. If the existence of factors is the desired conclusion, then the correlation matrix should be factor analyzed. Such factor analyses are presented in the following.

In this thesis, I have reanalyzed three reduced correlation matrices from Guilford's reports numbered 8, 12, and 35. These studies identified factors which Guilford termed divergent and convergent. In study number 8, the three highest loading tests on the Verbal Comprehension factor and the three tests with the highest loadings on the Numerical Facility factor were combined in a correlation matrix with the two highest loading tests on the factors identified as Word Fluency, Associational Fluency, Ideational Fluency, and Originality. One test loaded high on two factors; thus, there are a total of thirteen tests. An unrestricted maximum likelihood factor analysis

(UMLFA) was performed on the data. This factor analytic technique is used throughout this thesis. It is a technique originated by D. N. Lawley in 1940 and greatly developed by Karl Jöreskog in the past few years (an explanation of the technique is given in Jöreskog, 1967b). To understand the points made in this section it is sufficient to know that this technique gives the most likely solution for a given number of factors under the assumption of normally distributed underlying traits. The pattern of loadings on the factors indicates the contributions of the factors to the behavior (test scores) being analyzed. The Varimax Rotated solution for two factors is given in Table 1.2.1. While the first factor is largely determined by the assumed convergent tests, test number five has higher loadings than three of the convergent tests and test number seven has the highest loading of all. The negative loading of test number eight could be made positive by simply reversing the scoring. The second factor is determined largely by the Originality and Ideational Fluency tests. While this analysis is not perhaps the most convincing, it seems to permit a more lenient criticism than that of McNemar and Thorndike, i.e., that, although many of the Guilford so-called "divergent" tests do not appear to define a convincing "divergent" factor, some of the tests do appear to define a factor on which the common "convergent" tests (verbal comprehension and numerical facility) load poorly.

Similar analyses were performed on reduced correlation matrices for Guilford's Studies 12 and 35. The adaptive flexibility factor in Study 12 loads poorly on the divergent factor. Otherwise, the divergent and convergent factors are evident. The evidence in Study 35 is not as good. Five

Table 1.2.1

(Guilford, Wilson, and Christensen)

Maximum Likelihood Solution for Two Factors

Study #8
(1952)

Unique Variances

1	0.697	0.822	0.388	0.520	0.652	0.721	0.503	0.684
	0.569	0.705	0.733	0.657	0.649			

Varimax-Rotated Factor Matrix

Ideational Fluency 1	-0.072	0.546
Originality 1	0.169	0.387
Ideational Fluency 2	-0.034	0.782
Originality 2	-0.031	0.692
Word Fluency 1	0.580	0.105
Associational Fluency 1	0.339	0.406
Word Fluency 2	0.689	0.150
Associational Fluency 1 (Verbal Comprehension 1)	-0.544	0.140
Verbal Comprehension 2	0.656	0.020
Verbal Comprehension 3	0.538	0.074
Numerical Facility 1	0.513	0.064
Numerical Facility 2	0.586	0.022
Numerical Facility 3	0.592	-0.005

Table 1.2.2

(Guilford, Berger, and Christensen)

Maximum Likelihood Solution for Two Factors

Study #12

(1955)

Unique Variances

1	0.433	0.619	0.790	0.840	0.844	0.780	0.801	0.853
	0.731	0.568	0.691	0.854	0.797			

Varimax-Rotated Factor Matrix

Elaboration 1	0.723	0.211
Elaboration 2	0.600	0.143
Originality 1	0.375	0.263
Adaptive Flexibility 1	-0.083	0.391
Originality 2	0.329	0.219
Ideational Fluency 1	0.454	-0.116
Ideational Fluency 2	0.441	-0.068
Adaptive Flexibility 2 (Verbal Comprehension 1)	-0.008	0.384
Verbal Comprehension 2	0.183	0.485
Numerical Facility 1	0.009	0.657
Verbal Comprehension 3	0.235	0.503
Numerical Facility 2	0.089	0.372
Numerical Facility 3	0.091	0.442

Table 1.2.3

(Hoepfner and Guilford)

Maximum Likelihood Solution for Two Factors

Study #35
(1965)

Unique Variances								
1	0.578	0.834	0.589	0.789	0.627	0.768	0.839	0.634
	0.494	0.676	0.358	0.684	0.597	0.504	0.573	0.582

Varimax-Rotated Factor Matrix

DFC 1	0.528	0.378
DFC 2	0.398	0.086
DFU 1	0.049	0.639
DSC 1	0.354	0.293
DFU 2	-0.008	0.610
DSU 1	0.443	0.189
DSC 2	0.171	0.362
DSU 2	0.463	0.390
CMI 1	0.488	0.517
CFC 1	0.569	-0.026
CMU 1	0.781	0.179
CFC 2	0.546	0.136
CMI 2	0.505	0.384
CSR 1	0.674	0.204
CMU 2	0.650	0.063
CSR 2	0.608	0.219

Key =	Position 1	Position 2	Position 3
	D = divergent	F = figural	C = classes
	C = convergent	S = symbolic	U = units
		M = semantic	I = implications
			R = relations

of the divergent subfactors have higher loadings on what appears to be a convergent factor.

To summarize this section, the Guilford studies do provide some evidence for the existence of divergent and convergent factors. The coherence of the divergent factor is not evident. The distinction between the two does not seem evident from the data.

1.3 E. Paul Torrance and the Minnesota Tests of Creative Thinking

E. Paul Torrance and his co-workers adapted a number of the Guilford tests and added a number of their own to form a creativity test battery. The tests are described in an appendix of Torrance's Guiding Creative Talent (1962). Unfortunately, Torrance does not report correlations in his research. Rather, to provide evidence for separate dimensions (intelligence and creativity), he ranks students on the basis of an intelligence score and separately on the basis of a creativity score. This creativity score is determined by summing the scores on the separate creativity tests. This is done without giving intertest correlations to justify such summing. In criticizing the Getzels and Jackson study which used similar tests, McNemar pointed out that although the median intercorrelation among the creativity tests was only .28, the authors went on and used a sum score for most of their analyses. The correlations of the IQ scores with the various subtests is given in column 6 of Table 1.4.1. McNemar found that the sum score correlated .40 with intelligence. I think a similar criticism can be leveled at Torrance. At any rate, Torrance after ranking the students selects the top 20% in each group. Then he eliminates those common to both groups.

Then he compares the remaining groups. This simply involves ignoring too much of the data to allow the final conclusions to be very convincing. He found a significant difference between the two groups, the high IQ group having a mean intelligence of 141.7 and the high creative group a mean IQ of 122.0.

In referring to the work of Torrance, R. L. Thorndike in his 1962 paper, referred to in the previous section, has the following comment to make:

> I would very much like to apply this same type of critical (if not creative) analysis to the tests that Torrance has been developing at Minnesota. So far, I have not encountered a set of data that lent themselves to this approach. Though Torrance has expressed commendable concern about rater reliability in appraising the protocols from his tests, I have not encountered the same type of concern about trait reliability, that is, the consistency with which his tests measure some common attribute to which a common designation may legitimately be applied. Though Torrance specifically disavows intending to produce a test to produce a Creativity Quotient that would constitute a characterization of an individual, he often uses a team of his tests as if they did produce one, or at least as if they had enough in common to justify pooling them into a single composite score. I would suggest that a good deal of further study of the behavior domain is needed before this is done.

1.4 The Getzels and Jackson Study

Getzels and Jackson (1962) administered a creativity battery to 533 students of above average intelligence in a mid-western school. One intelligence measure was obtained from the school, the Stanford-Binet, WISC, or Henmon-Nelson. Their study is one of the most widely known. They verified a number of rather interesting hypotheses relating to creativity and achievement, creativity and self-concept, creativity and conformity, and creativity and teacher preference. Yet, their analysis has come under extremely sharp criticism.

Table 1.4.1

Getzels and Jackson Study

Intercorrelations among Creativity and Intelligence Tests

Boys (above diagonal) N = 292

Variable Number	Test	1	2	3	4	5	6
		Variable Number					
1	Word Association		369	344	303	420	378
2	Uses	371		206	222	175	186
3	Hidden Shapes	351	197		159	414	366
4	Fables	320	276	153		220	131
5	Make-up Problems	488	279	525	269		246
6	Intelligence Quotient	371	147	303	115	393	

Girls (below diagonal) N = 241

Table 1.4.2

(Table 1 of R. L. Thorndike)

First Factor Loadings of the Getzels and Jackson Creativity Tests and IQ

	Boys	Girls
1. Word Association	.69	.70
2. Uses	.47	.48
3. Hidden Shapes	.58	.60
4. Fables	.41	.42
5. Make-up Problems	.58	.72
6. I.Q.	.52	.50
Average	.54	.57

From "Some Methodological Issues in the Study of Creativity" by R. L. Thorndike in Proceedings of the 1962 Invitational Conference on Testing Problems.

Table 1.4.3

Getzels and Jackson Study (Boys)

Maximum Likelihood Solution for One Factor

Unrotated Factor Matrix

1	0.725
2	0.430
3	0.559
4	0.375
5	0.581
6	0.506

Unique Variances

1	0.474	0.815	0.687	0.859	0.663	0.744

Table 1.4.4

Getzels and Jackson Study (Boys)

Maximum Likelihood Solution for Two Factors

Unique Variances

1	0.264	0.814	0.0	0.865	0.707	0.769

Varimax-Rotated Factor Matrix

1	0.184	0.838
2	0.128	0.412
3	0.981	0.196
4	0.091	0.356
5	0.338	0.423
6	0.298	0.377

The correlation table for the data in this study is given in Table 1.4.1. For girls, the average correlation among the creativity tests is .32 while the average correlation between the creativity tests and the intelligence test is .27. For boys, the average correlation among the creativity tests is .28, while the average correlation between the creativity tests and intelligence is .26. Wallach and Kogan point out, in addition, that nine of the ten creativity tests are significantly correlated (p less than .05) with the intelligence test. There is scant evidence here for a unified dimension distinct from intelligence.

In reanalyzing the Getzels and Jackson data, R. L. Thorndike makes the following statement:

> Getzels and Jackson emphasize the lack of correlation between the traditional intelligence test and the measures that they used to appraise creativity. However, the intercorrelations of the five "creativity" tests were themselves not very high. It is of some interest to extract a first factor from this table of correlations and compare the factor loadings of the several tests. The results are shown in Table 1 (1.4.2). Thus, we see that on the first factor common to these six measures, the factor loadings are all fairly modest and the loading for the conventional intelligence test falls about midway among the "creativity" tests.

In reanalyzing the Getzels and Jackson data using UMLFA, the one and two factor solutions given in Tables 1.4.3 and 1.4.4 were obtained. It is clear from this reanalysis that no single two factor structure corresponding to intelligence and creativity is present in the Getzels and Jackson data.

1.5 Summary

A number of other studies could be described to continue this same kind of analysis, but I think the point should be sufficiently clear. A two factor

structure corresponding to intelligence and creativity has not been convincingly demonstrated in even the most noted studies. In addition, using a sum score for creativity is hardly justified unless the individual measures are adequately correlated. This seems to be the necessary requirement for the data if the researcher is to avoid being deserving of the following criticism of McNemar: "The factor analytic studies indicate either no, or a trivially small, general creativity factor in these tests, yet these self-characterized 'bold, adventurous' reformers do not hesitate to advocate a total score which is nearly devoid of meaning."

CHAPTER 2

AN ASSOCIATION APPROACH TO CREATIVITY

2.1 Introduction

The conclusion reached in the preceding chapter was that the empirical evidence for the existence of a creativity dimension was unconvincing. Michael Wallach and Nathan Kogan (1965a) suggested concentrating on a less diffuse set of abilities closely related to association in an attempt to get at creativity. These association abilities, they hypothesized, could best be assessed in an atmosphere that was relaxed and game-like. The Guilford tests differed in that they were administered with strict time constraints. Wallach and Kogan devised a set of materials, some original, some adapted from previously used creativity tests. They used these materials in their research study.

Before considering their actual research in Chapter 3, a theoretical basis for their approach to creativity will be presented in Chapter 2.

2.2 Sarnoff A. Mednick's "The Associative Basis of the Creative Process"

In 1962, Mednick published his noted article on the associative basis of the creative process. In it, he defines creative thinking as ". . . the forming of associative elements into new combinations which either meet specific requirements or are in some way useful. The more mutually remote the elements of the new combination, the more creative the process or solution." To support this definition, Mednick listed a number of quotes by ostensibly creative people. The quotes are from Ghiselin's The Creative Process (1952).

Einstein suggests that "combinatory play seems to be the essential feature in productive thought."

Poincaré tells of being unable to sleep one night when "ideas rose in crowds; I felt them collide until pairs interlocked so to speak, making a stable combination." Later he states that "to create consists of making new combinations of associative elements which are useful."

Mozart refers to occasions upon which his "ideas flow best and most abundantly."

Dryden describes the production of "a confus'd Mass of Thoughts, tumbling over one another in the Dark."

A. E. Hausman, in his The Name and Nature of Poetry, speaks of a spring of ideas bubbling up within him.

It was based upon considerations such as these that Mednick formulated his theory of creative thinking. Later on (1969), he replied to a letter by R. W. Hood in which he agreed with Hood that it would be advisable to drop the requirement of usefulness from the definition and simply stress the meeting of specific requirements. A survey of the Psychological Abstracts shows that Mednick became more and more interested in research on schizophrenia and less and less on creativity after 1962.

In his 1962 article, Mednick stated a number of hypotheses which are relevant to the Wallach and Kogan research. One such hypothesis was that "the greater the number of associations that an individual has to the requisite elements of a problem, the greater the probability of his reaching a creative solution." Mednick thus considers the ability to generate associations as a necessary condition for creativity. Another hypothesis of Mednick is that "it seems likely that this variable (number of associations) will not be related to speed of creative solution." This supports Wallach

and Kogan's insistence on a game-like setting with no time constraints in testing for creativity.

Mednick decided to try to get at this ability to generate associations by devising his Remote Associates Test (RAT). His idea was to provide stimuli from mutually remote associative clusters and have the subject find a mediating link which combines them. He stressed the point that the mediating link must be strictly associative rather than logical. The following is an example of an item on the RAT. The subject would be presented with the words rat, blue, and cottage. He would be expected to reply "cheese" as a mediating link among the three items.

In 1962, Mednick reported a correlation of .70 between RAT scores and creativity ratings by design instructors in a college of architecture. With first year psychology graduate students, Mednick found that the Remote Associates Test differentiated between those rated high and low by their instructors on creativity in research. On the other hand, C. W. Taylor (1964a) found that the test did not correlate well with ratings obtained by high school students in a program of research sponsored by the National Science Foundation. At the present time, research seems to exist to support both viewpoints. The difficulty here is that the ratings involved are suspect. Thurstone warned in 1950 that "to make judgments about students as to their originality is so different from the customary academic judgments about scholarship that there is some question whether we can trust available judgments for this kind of study."

Correlations of approximately .40 between RAT scores and various measures of intelligence have been reported in the literature. Michael Wallach (1970)

cites values of .41, .31, .35, and ,48 as reported in studies by M. Mednick, Rainwater, Mendelsohn and Griswold, and Laughlin respectively. Measures of intelligence in these studies included scores on the Miller Analogies Test, Terman's Concept Mastery Test, and several vocabulary tests. These correlations, together with differing conceptions of creativity in Architecture and Science, could account for the results of the rating studies cited. It is simply not possible to justify the validity of a creativity measure by means of an external criterion at present.

2.3 C. W. Taylor and the Utah Conferences on Creativity

C. W. Taylor has published several books on creativity, most of them derived from the proceedings of the conferences on creativity which he has sponsored at Utah. While he provides some support for the association approach to creativity, he probably would consider the approach too narrow. In 1963, Taylor (C. W. Taylor, Smith, & Ghiselin, 1963) tried to determine criteria for creative performance. He concluded that the problem of criteria is very complex, and that no single criteria of performance will be acceptable or adequate for indicating creativity. He does, however, support the hypothesis that productivity is an important ingredient of creativity. In his Creativity: Progress and Potential, (1964a), Taylor stresses the point that creativity is a quality possessed by all people. He states also that "in seeking creative talent, perhaps we are interested in those who have fluent bursts of ideas if at the same time they can validly identify the best of their own ideas."

2.4 L. L. Thurstone's "Creative Talent"

In 1950, Thurstone delivered a paper on creative talent to the Educational Testing Service Conference on Testing. A great deal of the content of that address can be used to provide a theoretical basis for the association approach to creativity. A number of his hypotheses are listed below:

> . . . creative talent is qualitatively the same at all levels.
>
> To be extremely intelligent is not the same as to be gifted in creative work. This may be taken as a hypothesis.
>
> . . . it is doubtful whether they (referring to the Quiz Kids) are also fluent in producing ideas.
>
> Although there seems to be some conflict between scholarship (academic achievement) and creative talent, they are probably positively correlated.
>
> . . . this instruction (referring to instruction in the scientific method) has little to offer in teaching students how to produce ideas. It is this prefocal stage of the process of problem solving that especially needs investigation.
>
> . . . mere fluency of ideas does not adequately represent creative talent. Fluency in seeing implications may be an important characteristic of creative ability. Some forms of fluency may signify intelligence without implying creative talent.
>
> A hypothesis that should be considered in the experimental study of problem solving is that the moment of insight is often, perhaps always, in relaxed and dispersed attention.

These statements by Thurstone lend theoretical weight to the association approach to creativity. He stresses the production of ideas as the primary ingredient in creative talent. Granted, it is not the whole story. The question still may be asked: how much of the story is it? Thurstone supports the hypothesis that creativity is distinct from intelligence though positively correlated with it. He thinks that creativity is positively correlated with achievement.

It is worth pointing out that in considering problem solving, Thurstone is concerned with the prefocal stage before logic and deduction take over. It operates best in a relaxed atmosphere. This is support for the game-like and nonevaluative atmosphere in testing. Thurstone adds a seemingly creative person to the list provided by Mednick, Thomas Edison. In his autobiography, Thurstone stresses Edison's tremendous productivity. "For every experimental failure he seemed to produce three more experiments to try." In addition, Edison "seemed to have a startling fluency of ideas which often ranged far from the problem."

In general then, there is much in Thurstone's address to support this approach which concentrates on productivity. Whether it will prove to be so narrow a factor as to account for very little remains to be seen. In fact, it will be shown that the factor tapped by the Wallach and Kogan materials has an interesting and psychologically interpretable substructure.

Thurstone's concluding remarks in his address seem an appropriate way to conclude this chapter:

> Experimental studies should be on two major problems, namely, to inquire about the nature of the thinking that leads to a moment of insight, and to investigate empirically how to differentiate creative talent by objective and experimental procedures. It is conceivable that we may discover how to select people with creative talent before we learn much about the nature of that kind of talent.

CHAPTER 3

THE WALLACH AND KOGAN RESEARCH: PRESENTED AND REANALYZED

3.1 Introduction

With the theoretical background presented in the preceding chapter, that is, an approach to creativity strongly grounded in association and the constraint of a nonevaluative setting for obtaining the measures, consider the Wallach and Kogan study (1965a).

3.2 The Creativity Tests

Wallach and Kogan wanted materials that would tap a person's ability to produce associations. They wanted materials that would tap this ability in a variety of ways. They tried very simple tasks involving the naming of things having a certain property (red, round, etc.), the giving of uses for an object (brick, shoe, etc.), the giving of similarities between two different objects (potato and carrot, train and tractor, etc.), and the giving of possible interpretations or meanings for each of a variety of abstract visual patterns and line drawings. In essence, then, there were five tests. They were administered individually and orally to 151 fifth grade children in a New England public school district. The mean age of the students was 10 years, 8 months.

3.3 The Measures

Each item in each test was scored for total number of responses (productivity) and for number of unique responses (uniqueness). The total number was simply a count of the responses. The uniqueness of a response was defined with respect to the sample of children. If a response was

given by only one child, it was considered unique. In addition, measures of intelligence were obtained using tests from the WISC, SCAT, and STEP batteries. The intelligence tests were group administered.

3.4 Analysis of the Data

For the five creativity tests, the scores on each item were added together to obtain a total productivity score for each test and a total uniqueness score for each test. In order to justify this adding of the scores, Wallach and Kogan presented the necessary interitem correlations and item-test correlations. The complete data are presented in Wallach and Kogan's Modes of Thinking in Young Children (1965a). These procedures will be explained in greater detail when the data for the present research are presented.

In order to justify their claim for a unified dimension distinct from the intelligence dimension, Wallach and Kogan presented the three tables 3.4.1, 3.4.2, and 3.4.3. The average correlation among the creativity measures is .41, among the intelligence measures is .51, and between the intelligence and creativity measures is .09. Forty-three of the 45 correlations in both tables 3.4.1 and 3.4.2 are significant beyond the .05 level. Wallach and Kogan considered this good evidence for a unified dimension independent from the intelligence dimension. They considered the relatively high correlations in the creativity matrix as evidence that the dimension cuts across the verbal and visual stimuli. They did not attempt to extract factors from the data which would have shown this substructure more clearly if it did in fact exist.

3.5 Factor Analyses of the Wallach and Kogan Data

In 1967, James Ward (Manchester University) finally published a factor analysis of the total Wallach and Kogan correlation matrix. He used the

Table 3.4.1

(Wallach and Kogan)

Intercorrelations Among the Ten Creativity Measures

for the Total Sample (N = 151)

	2	3	4	5	6	7	8	9	10
1. Instances-uniqueness	08	41	24	33	32	27	07	35	20
2. Instances-number		35	45	22	41	27	30	33	42
3. Alternate uses-uniqueness			67	66	70	46	29	44	52
4. Alternate uses-number				53	74	49	39	39	58
5. Similarities-uniqueness					71	32	20	49	46
6. Similarities-number						45	38	52	58
7. Pattern meanings-uniqueness							29	55	50
8. Pattern meanings-number								25	40
9. Line meanings-uniqueness									64
10. Line meanings-number									

Note.--For 149 df, r's of .16 and .21 are significant at the .05 and .01 levels, respectively. Decimal points are omitted.

Table 3.4.2

(Wallach and Kogan)

Intercorrelations Among the Ten Intelligence Measures

for the Total Sample (N = 151)

	2	3	4	5	6	7	8	9	10
1. WISC-vocabulary (V)	18	37	56	38	55	53	59	43	44
2. WISC-picture arrangement (PA)		17	15	16	20	24	24	12	16
3. WISC-block design (BD)			34	34	51	37	38	29	26
4. SCAT-verbal (V)				70	71	71	80	70	77
5. SCAT-quantitative (Q)					71	65	69	74	77
6. STEP-mathematics (M)						67	73	60	65
7. STEP-science (S)							76	71	70
8. STEP-social studies (SS)								71	74
9. STEP-reading (R)									80
10. STEP-writing (W)									

Note.--For 149 df, r's of .16 and .21 are significant at the .05 and .01 levels, respectively. Decimal points are omitted.

Table 3.4.3

(Wallach and Kogan)

Intercorrelations Between the Ten Creativity and Ten Intelligence Measures for the Total Sample (N = 151)

	WISC V	WISC PA	WISC BD	SCAT V	SCAT Q	STEP M	STEP S	STEP SS	STEP R	STEP W
Instances-uniqueness	11	12	02	01	-11	06	00	05	00	-09
Instances-number	09	17	15	06	07	07	20	17	08	09
Alternate uses-uniqueness	14	11	-01	05	03	12	12	10	07	06
Alternate uses-number	13	09	06	16	13	22	15	18	14	16
Similarities-uniqueness	09	12	-03	09	02	09	07	08	01	01
Similarities-number	19	14	02	22	13	23	17	21	11	14
Pattern meanings-uniqueness	11	01	06	12	13	15	13	12	09	15
Pattern meanings-number	-13	12	-03	-01	00	-05	01	-04	-02	05
Line meanings-uniqueness	22	21	11	21	21	17	23	21	17	19
Line meanings-number	03	09	04	11	12	02	07	10	11	10

Note.--For 149 df, r's of .16 and .21 are significant at the .05 and .01 levels, respectively. Decimal points are omitted.

Promax method of Hendrickson and White (1964). This method of factor analysis includes obtaining a principal components solution rotated to Varimax criterion and then powering the matrix of normalized Varimax loadings to obtain a criterion matrix of optimal simple structure. The original Varimax factors are then rotated to produce the best fit to this "ideal" matrix. The complete solution together with the intercorrelations of the factors is given in Table 3.5.1.

Ward interpreted Factor I as a school attainment factor, II as a creativity factor, III as a number of responses factor, and IV as a weak general factor. In general, his analysis did not shed much light on the substructure of the creativity dimension.

In 1968, Francis Fee (Anterim Education Committee) decided to apply a different factor technique to the Wallach and Kogan data. He used a centroid analysis on the creativity and intelligence correlations separately. He extracted two factors in each case, hypothesized a simple structure matrix on the basis of this analysis, and then factored the entire matrix using Horst's Multiple Group Method (1965). Fee's results are presented in Table 3.5.2.

Factors A and B are first order representations of second order factors. They were rotated to simple structure on the basis of the hypothesized matrix mentioned above. Factors I through IV are first order factors, and they support the substructure hypothesis rather well. Factor I appears to be a "creativity-verbal" factor, and Factor II appears to be a "creativity-visual" factor. The agreement with Ward's analysis is rather minimal. Ward, in a note to the Fee publication, criticizes Fee's use of an hypothesized matrix which really prejudges the final result.

Table 3.5.1

(James Ward)

Factor Structure from Oblique Factorization of Twenty Cognitive Tests

(Wallach and Kogan, 1965a)

Test	Factor I	Factor II	Factor III	Factor IV
1. Instances--uniqueness	-0.056	0.509	-0.472	0.312
2. Instances--number	0.110	0.472	0.487	0.439
3. Alternate uses--uniqueness	0.064	0.836	0.004	0.218
4. Alternate uses--number	0.175	0.796	0.283	0.200
5. Similarities--uniqueness	0.033	0.772	-0.106	0.177
6. Similarities--number	0.179	0.869	0.130	0.257
7. Pattern meanings--uniqueness	0.148	0.653	0.200	0.099
8. Pattern meanings--number	-0.033	0.418	0.661	0.097
9. Line meanings--uniqueness	0.220	0.717	0.094	0.354
10. Line meanings--number	0.094	0.742	0.418	0.164
11. WISC vocabulary	0.620	0.192	-0.375	0.494
12. WISC picture arrangement	0.182	0.164	0.001	0.749
13. WISC block design	0.443	0.037	-0.101	0.651
14. SCAT--verbal	0.886	0.165	-0.082	0.282
15. SCAT--quantitative	0.860	0.098	0.097	0.203
16. STEP--mathematics	0.831	0.181	-0.182	0.439
17. STEP--science	0.846	0.167	-0.021	0.417
18. STEP--social studies	0.887	0.184	-0.099	0.422
19. STEP--reading	0.859	0.108	0.026	0.176
20. STEP--writing	0.889	0.116	0.111	0.172

Intercorrelations of Table A1 Factors

I.	1.000	0.143	-0.031	-0.345
II.	0.143	1.000	0.116	-0.323
III.	-0.031	0.116	1.000	0.137
IV.	-0.345	-0.323	0.137	1.000

Table 3.5.2

(Francis Fee)

Supermatrix of First-Order General Factor Matrix and First-Order Rescaled Simple Structure Factors of Twenty Cognitive Tests

(Wallach and Kogan, 1965a)

Test	Factor					
	A	B	I	II	III	IV
1. Instances--uniqueness	420	-045	531	-072	036	-152
2. Instances--number	311	053	-044	282	068	000
3. Alternate uses--uniqueness	639	-023	652	011	-019	-056
4. Alternate uses--number	592	047	507	084	-021	038
5. Similarities--uniqueness	593	-029	668	-038	-012	-079
6. Similarities--number	641	053	593	058	-022	035
7. Pattern meanings--uniqueness	407	004	050	287	-037	081
8. Pattern meanings--number	298	-078	-077	296	011	-051
9. Line meanings--uniqueness	430	108	072	268	036	088
10. Line meanings--number	481	-018	087	318	-013	027
11. WISC vocabulary	050	483	116	-048	076	371
12. WISC picture arrangement	064	333	028	026	394	-189
13. WISC block design	-051	470	-086	022	360	006
14. SCAT--verbal	000	706	023	-009	-024	742
15. SCAT--quantitative	-052	692	-093	033	-012	727
16. STEP--mathematics	033	667	116	-060	087	540
17. STEP--science	001	703	-018	017	028	676
18. STEP--social studies	013	729	035	013	024	700
19. STEP--reading	-032	693	-026	-002	-052	772
20. STEP--writing	-039	706	-078	032	-054	796
	1.000		1.000			
Intercorrelations	-235	1.000	-531	1.000		
			-072	020	1.000	
			-134	025	-501	1.000

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This is a good example of the difficulties that arise in the use of factor techniques, especially when different techniques are applied to the same data. Has the imposition of an hypothesized matrix so determined the final structure that almost any set of data will appear to have this structure when subjected to a similar analysis? This is a problem that exists in factor studies, one which is not going to disappear in the near future. Individual preferences will have to be tolerated until some agreement can be worked out among psychologists.

In the research to be presented, an unrestricted maximum likelihood factor analysis (UMLFA) technique developed by Karl Jöreskog (1966) is used. This method extracts factors in such a way as to give a maximum likelihood best fit to the correlations. The factors do not account in turn for maximum variance as is the case in the principal components technique. Neither is the fit to the given correlations the best least squares fit. A one factor solution in a maximum likelihood technique would be that particular matrix which has the maximum likelihood of reproducing the original given correlations under the assumption of a single normally distributed latent trait that accounts for the original behavior. The method also includes a chi-square test of goodness of fit which is dependent on the size of the sample under study and the data's deviation from a multivariate normal distribution. A more complete description of the UMLFA technique is presented in Jöreskog (1967b). In order to evaluate the usefulness of this technique, I have applied it to the Wallach and Kogan matrix. I will also apply it to the data for several other studies to be presented in the next chapter. Tables 3.5.3, 3.5.4, and 3.5.5 contain the two, three, and four factor solutions

Table 3.5.3

(Wallach and Kogan)

Maximum Likelihood Solution for Two Factors

Latent Roots

1	21.252	11.440	2.270	1.781	1.650	1.424	1.367	1.227	1.028	0.931
	0.852	0.829	0.784	0.694	0.672	0.648	0.554	0.499	0.416	0.372

Unique Variances

1	0.840	0.774	0.349	0.349	0.448	0.218	0.668	0.814	0.591	0.509
	0.642	0.938	0.824	0.235	0.316	0.349	0.312	0.216	0.307	0.246

Varimax-Rotated Factor Matrix

1. Instances--uniqueness	-0.036	0.398
2. Instances--number	0.098	0.465
3. Alternate uses--uniqueness	0.031	0.807
4. Alternate uses--number	0.131	0.796
5. Similarities--uniqueness	0.009	0.743
6. Similarities--number	0.141	0.873
7. Pattern meanings--uniqueness	0.108	0.566
8. Pattern meanings--number	-0.033	0.430
9. Line meanings--uniqueness	0.193	0.609
10. Line meanings--number	0.059	0.698
11. WISC vocabulary	0.589	0.106
12. WISC picture arrangement	0.209	0.137
13. WISC block design	0.420	-0.004
14. SCAT--verbal	0.871	0.076
15. SCAT--quantitative	0.827	0.023
16. STEP--mathematics	0.800	0.109
17. STEP--science	0.826	0.080
18. STEP--social studies	0.883	0.091
19. STEP--reading	0.832	0.020
20. STEP--writing	0.868	0.034

Table 3.5.4

(Wallach and Kogan)

Maximum Likelihood Solution for Three Factors

Latent Roots

1	24.344	11.938	2.707	1.913	1.750	1.510	1.447	1.301	1.146	1.035
	0.951	0.941	0.828	0.770	0.723	0.685	0.580	0.558	0.463	0.399

Unique Variances

1	0.779	0.769	0.349	0.346	0.433	0.216	0.644	0.749	0.579	0.425
	0.491	0.920	0.767	0.235	0.279	0.308	0.311	0.195	0.262	0.165

Varimax-Rotated Factor Matrix

1. Instances--uniqueness	-0.033	0.345	0.318
2. Instances--number	0.085	0.473	0.022
3. Alternate uses--uniqueness	0.024	0.779	0.210
4. Alternate uses--number	0.116	0.796	0.080
5. Similarities--uniqueness	0.002	0.705	0.265
6. Similarities--number	0.129	0.847	0.223
7. Pattern meanings--uniqueness	0.093	0.588	-0.036
8. Pattern meanings--number	-0.051	0.472	-0.162
9. Line meanings--uniqueness	0.178	0.623	0.039
10. Line meanings--number	0.033	0.747	-0.126
11. WISC vocabulary	0.606	0.047	0.373
12. WISC picture arrangement	0.211	0.116	0.148
13. WISC block design	0.427	-0.038	0.223
14. SCAT--verbal	0.870	0.086	0.037
15. SCAT--quantitative	0.821	0.076	-0.202
16. STEP--mathematics	0.806	0.088	0.184
17. STEP--science	0.824	0.084	0.057
18. STEP--social studies	0.885	0.084	0.126
19. STEP--reading	0.829	0.074	-0.214
20. STEP--writing	0.869	0.097	-0.264

Table 3.5.5

(Wallach and Kogan)

Maximum Likelihood Solution for Four Factors

Unique Variances

1	0.746	0.767	0.344	0.269	0.435	0.201	0.602	0.742	0.0	0.380
	0.480	0.904	0.767	0.235	0.277	0.307	0.309	0.196	0.263	0.166

Varimax-Rotated Factor Matrix

1. Instances--uniqueness	0.123	-0.047	0.315	0.370
2. Instances--number	0.090	0.087	0.466	0.025
3. Alternate uses--uniqueness	-0.019	0.026	0.787	0.188
4. Alternate uses--number	-0.079	0.127	0.842	0.017
5. Similarities--uniqueness	0.078	-0.003	0.693	0.281
6. Similarities--number	0.008	0.131	0.859	0.208
7. Pattern meanings--uniqueness	0.313	0.092	0.539	0.036
8. Pattern meanings--number	0.077	-0.039	0.469	-0.173
9. Line meanings--uniqueness	0.804	0.155	0.510	0.263
10. Line meanings--number	0.368	0.035	0.693	-0.057
11. WISC vocabulary	0.001	0.589	0.036	0.414
12. WISC picture arrangement	0.102	0.202	0.091	0.193
13. WISC block design	0.006	0.415	-0.045	0.242
14. SCAT--verbal	0.022	0.868	0.074	0.076
15. SCAT--quantitative	0.117	0.827	0.052	-0.148
16. STEP--mathematics	-0.068	0.801	0.097	0.193
17. STEP--science	0.052	0.820	0.065	0.105
18. STEP--social studies	-0.008	0.879	0.076	0.158
19. STEP--reading	0.070	0.837	0.055	-0.169
20. STEP--writing	0.088	0.880	0.078	-0.216

using the UMLFA technique. Note that the amount of unique variance in each variable after the factors have been extracted is reported. This information can be used to determine how much of the variance is accounted for by the factors. It also indicates the commonality of the variance being accounted for.

For two factors, the creativity-intelligence distinction is quite clearly indicated. Note, however, that measures 1, 2, 11, 12, and 13 have high unique variances. This means that they do not share much in common with the tests loading high on the two extracted factors. When a third factor is extracted, it is pretty much determined by these variables. A fourth factor is difficult to interpret. The reason for not arriving at a fairly simple structure is that the tests involved do not really form a fairly simple structure. Or perhaps, a fairer way to state the difficulty would be that the presence of 1, 2, 11, 12, and 13 in the battery provide enough additional variation to keep the creativity substructure from appearing. In order to test this hypothesis, I deleted variables 1, 2, 11, 12, and 13 from the battery and submitted the remaining 15 variables to UMLFA. The results were very clear. Solutions for two, three, and four factors are given in Tables 3.5.6, 3.5.7, and 3.5.8. When two factors are extracted the intelligence-creativity distinction is clear. When a third factor is extracted, it clearly shows the division of the creativity factor into a "creativity-verbal" factor (variables 1-4) and a "creativity-visual" factor (variables 5-8). This is a good justification for deleting the Names Test from the creativity battery which has been done in several studies.

Lee Shulman (1966) in a review of their work, has criticized Wallach and Kogan for generalizing their results to all young children. They tested

Table 3.5.6

(Wallach and Kogan Reduced)

Maximum Likelihood Solution for Two Factors

Latent Roots

1	20.446	11.136	2.033	1.526	1.376	1.272	1.224	0.956	0.914	0.764
	0.724	0.639	0.589	0.558	0.425					

Unique Variances

1	0.348	0.355	0.209	0.437	0.816	0.672	0.514	0.604	0.240	0.301
	0.368	0.322	0.233	0.289	0.224					

Varimax-Rotated Factor Matrix

Alternate uses--uniqueness	0.121	0.798
Alternate uses--number	0.019	0.803
Similarities--uniqueness	0.126	0.880
Similarities--number	-0.004	0.750
Pattern meanings--uniqueness	-0.042	0.427
Pattern meanings--number	0.103	0.563
Line meanings--uniqueness	0.054	0.695
Line meanings--number	0.182	0.602
SCAT--verbal	0.867	0.094
SCAT--quantitative	0.835	0.041
STEP--mathematics	0.786	0.119
STEP--science	0.819	0.087
STEP--social studies	0.870	0.101
STEP--reading	0.843	0.031
STEP--writing	0.879	0.050

Table 3.5.7

(Wallach and Kogan Reduced)

Maximum Likelihood Solution for Three Factors

Latent Roots

1	21.759	13.187	2.725	1.692	1.450	1.384	1.302	1.121	0.999	0.839
	0.758	0.660	0.648	0.612	0.534					

Unique Variances

1	0.359	0.366	0.163	0.406	0.777	0.606	0.261	0.472	0.239	0.287
	0.324	0.321	0.226	0.275	0.212					

Varimax-Rotated Factor Matrix

Alternate uses--uniqueness	0.123	0.664	0.430
Alternate uses--number	0.024	0.699	0.379
Similarities--uniqueness	0.131	0.820	0.385
Similarities--number	0.001	0.713	0.293
Pattern meanings--uniqueness	-0.048	0.239	0.405
Pattern meanings--number	0.097	0.308	0.538
Line meanings--uniqueness	0.037	0.331	0.793
Line meanings--number	0.172	0.312	0.633
SCAT--verbal	0.867	0.095	0.034
SCAT--quantitative	0.834	-0.037	0.125
STEP--mathematics	0.796	0.194	-0.075
STEP--science	0.819	0.081	0.031
STEP--social studies	0.872	0.118	0.009
STEP--reading	0.840	-0.054	0.126
STEP--writing	0.878	-0.034	0.128

Table 3.5.8

(Wallach and Kogan Reduced)

Maximum Likelihood Solution for Four Factors

Unique Variances

1	0.266	0.359	0.175	0.381	0.717	0.582	0.372	0.0	0.231	0.288
	0.329	0.315	0.210	0.257	0.181					

Varimax-Rotated Factor Matrix

Alternate uses--uniqueness	0.021	0.132	0.825	0.186
Alternate uses--number	0.105	0.031	0.793	0.009
Similarities--uniqueness	0.130	0.138	0.886	-0.067
Similarities--number	0.189	0.005	0.734	-0.212
Pattern meanings--uniqueness	0.100	-0.043	0.407	0.324
Pattern meanings--number	0.376	0.094	0.478	0.197
Line meanings--uniqueness	0.426	0.042	0.608	0.275
Line meanings--number	0.889	0.155	0.431	-0.024
SCAT--verbal	0.042	0.868	0.083	-0.082
SCAT--quantitative	0.090	0.832	0.009	0.110
STEP--mathematics	-0.014	0.793	0.129	-0.160
STEP--science	0.083	0.817	0.064	-0.075
STEP--social studies	0.035	0.874	0.093	-0.127
STEP--reading	0.046	0.843	0.006	0.171
STEP--writing	0.054	0.884	0.022	0.188

only 151 children at age 10 years 8 months. Shulman suggested that a more appropriate title for their book would have been "Modes of Thinking in Fifth Grade Children." This is a valid criticism. If creativity measures are to be relevant to education, as Wallach and Kogan claim they may be, then they must be studied at a variety of age levels and under different testing conditions. What will correspond to a game-like atmosphere in studies of college and high school students? Over what range of intelligence will the results be reproducible? Since 1965, a number of studies have attempted to replicate the Wallach and Kogan results at various age levels. Results of these studies will be considered in the following chapter.

CHAPTER 4

RELEVANT RESEARCH SINCE 1965: PRESENTED AND REANALYZED

4.1 Introduction

A few research studies using the Wallach and Kogan materials have been carried out in the last few years. The materials used in each study were not exactly the same. William Ward (Educational Testing Service) has used the materials in studies with elementary school students. Ward has also begun to study a possible quality measure to be obtained from the responses. Cropley and Maslany (University of Saskatchewan) have administered the materials to two different groups of university students. Wallach and Wing (Duke University) have administered the materials to the freshman class at Duke. Conditions for administering the materials have included individual administration, group administration, and administration by mail. The results of these studies are rather consistent.

4.2 Research with Elementary School Children

William Ward (1968a) has administered the Wallach and Kogan materials to two groups of children ranging in age from five to eight years. He deleted the similarities test from his materials with these young children. In one group, an intelligence measure was derived from the Block Design and Object Assembly subtests of the WISC battery. Intelligence measures for the second group were derived from two forms of the Peabody Picture Vocabulary Test. Ward's correlation tables are given in Tables 4.2.1 and 4.2.2.

The results in group 1 (34 boys; mean age 8 years, 2 months) are clear. The average correlation among the creativity measures is .63. Only one

Table 4.2.1

(W. C. Ward)

Creativity Intercorrelations and Correlations with IQ,

Study 1 (N = 34)

Measure	1	2	3	4	5	6	7
1. Instances-uniqueness	-	.44	.72	.92	.39	.54	-.08
2. Uses-uniqueness		-	.50	.42	.94	.52	-.11
3. Patterns-uniqueness			-	.76	.53	.98	-.03
4. Instances-fluency				-	.39	.80	-.07
5. Uses-fluency					-	.54	-.17
6. Patterns-fluency						-	-.11
7. IQ							-

Note.--For 32 df, r's of .34 and .44 are significant at the .05 and .01 levels, respectively.

Table 4.2.2

(W. C. Ward)

Creativity Intercorrelations and Correlations with IQ

Study 2

Measure	1	2	3	4	5	6	7
1. Instances-unique		.55	.04	.89	.66	-.01	-.38
2. Uses-unique	.50		.05	.60	.95	.05	-.35
3. Patterns-unique	.22	.13		.13	.08	.84	.41
4. Instances-fluency	.92	.52	.21		.72	.13	-.34
5. Uses-fluency	.43	.85	-.01	.50		.07	-.27
6. Patterns-fluency	.30	.30	.82	.35	.13		.29
7. IQ	-.03	.20	-.12	-.01	.12	.04	

Note.--Males to right and above diagonal, N = 41; females to left and below diagonal, N = 46.

For 39 df, r's of .30 and .39 are significant at the .05 and .01 levels, respectively. For 44 df, r's of .29 and .37 are significant at the .05 and .01 levels, respectively.

intelligence measure was used. The average correlation between the intelligence measure and the creativity measures was -.10. The tests had been administered at a summer camp, individually, and in a relaxed atmosphere.

In Ward's second study (41 boys; 46 girls; mean age 5 years, 9 months) the creativity-intelligence distinction was not corroborated. In fact, the creativity dimension itself was not determined by the data. The main difficulty in this study was that the Patterns Tests correlated very low with the other tests. Ward mentions that the number of bizarre responses was large and that the figural materials are probably not appropriate for children this young. This seems to be a reasonable explanation for the data.

In applying the UMLFA technique to Ward's Study 2 data, a two factor solution shows that the hypothesized structure is not present. In fact, one would be hard pressed to account for the structure that UMLFA identifies by a psychological explanation. Table 4.2.3 gives the UMLFA Two Factor Solution for the 41 boys. Table 4.2.4 gives the UMLFA Two Factor Solution for the 46 girls. A three factor solution for the 41 boys is given in Table 4.2.5. It shows that the data break down into a uses factor, a patterns factor, and an instances factor. Neither an intelligence factor nor a uniqueness factor appears.

In the case of Study 1, the .98 correlation between the uniqueness and productivity measures on the patterns test probably accounts for the fact that the matrix is not positive definite. That is to say, it appears that variable 6 is a linear combination of variables 1 through 5. Thus, all of its variance can be accounted for in terms of these 5 preceding variables. The UMLFA program uses the inverse of the unique variance of each variable in its

Table 4.2.3

(W. C. Ward)

Maximum Likelihood Solution for Two Factors

Study #2 (41 Boys)

Unique Variances							
1	0.321	0.602	0.0	0.329	0.0	0.140	1.218

Varimax-Rotated Factor Matrix		
Instances-unique	0.659	-0.032
Uses-unique	0.949	-0.053
Patterns-unique	0.108	0.994
Instances-fluency	0.722	0.052
Uses-fluency	1.000	-0.029
Patterns-fluency	0.094	0.835
IQ	-0.257	0.441

Table 4.2.4

(W. C. Ward)

Maximum Likelihood Solution for Two Factors

Study 2 (46 Girls)

Unique Variances							
1	0.136	0.711	0.0	0.023	0.725	0.295	0.985
Varimax-Rotated Factor Matrix							
Instances-unique			0.145		0.918		
Uses-unique			0.087		0.531		
Patterns-unique			0.997		0.082		
Instances-fluency			0.130		0.980		
Uses-fluency			-0.053		0.522		
Patterns-fluency			0.803		0.246		
IQ			-0.121		0.010		

Table 4.2.5

(W. C. Ward)

Maximum Likelihood Solution for Three Factors

Study #2 (41 Boys)

Unique Variances

1	0.046	0.0	0.247	0.0	0.105	0.0	1.037

Varimax-Rotated Factor Matrix

Instances-unique	0.900	0.126	0.148
Uses-unique	0.389	0.122	0.913
Patterns-unique	0.075	0.826	-0.000
Instances-fluency	0.977	0.165	0.131
Uses-fluency	0.416	-0.037	0.759
Patterns-fluency	0.176	0.977	0.123
IQ	-0.045	0.020	0.236

Table 4.2.6

(W. C. Ward)

Maximum Likelihood Solution for Two Factors

Study #1

Unique Variances						
1	0.129	0.113	0.348	0.028	0.0	0.971

Varimax-Rotated Factor Matrix		
Instances-unique	0.189	0.914
Uses-unique	0.902	0.271
Patterns-unique	0.379	0.713
Instances-fluency	0.176	0.970
Uses-fluency	0.974	0.225
IQ	-0.165	-0.040

iterative procedure. If one variable is a linear combination of the other variables, the maximum likelihood technique can not be used directly. This is not entirely prohibitive, however. One can eliminate the dependent variable and use the UMLFA technique on the remaining variables. This was done, and the UMLFA Two Factor Solution for the reduced correlation matrix is given in Table 4.2.6. The creativity-intelligence distinction is not clear in this case.

To summarize, the studies of Ward gave partial support to the Wallach and Kogan hypotheses. There were difficulties, however, in working with very young children.

4.3 The Cropley Australian Study

In 1968, A. J. Cropley reported his first study using the Wallach and Kogan materials. Cropley tested 124 first year university students, all male, with a mean age of 18 years, 4 months. The study was done in Australia with the tests group administered but having no imposed time limits. In addition, five intelligence tests devised by the Australian Council for Educational Research were administered. The results are given in Table 4.3.1.

In general, the results support the Wallach and Kogan hypothesis of a dimension distinct from intelligence, but the evidence is not as convincing as that in the Wallach and Kogan study itself. Notice particularly the erratic correlations of the Names Test with the other creativity tests in the battery. Cropley presented a factor analysis of his correlation data. It is reproduced in Table 4.3.2. Unfortunately, Cropley used a

Table 4.3.1

(A. J. Cropley)

Means, Standard Deviations and Intercorrelations for All Variables

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Mean	45.4	34.3	20.9	19.8	20.4	2.26	2.15	1.59	4.89	4.20	17.0	14.8	39.0	27.4	20.3
S.D.	19.6	14.5	12.2	8.70	9.47	2.85	2.51	2.33	3.43	3.39	4.48	4.64	10.6	12.3	11.5
Fluency Scores:															
1. Names	-	491	241	148	136	610	233	209	-017	135	-057	-062	-125	-055	-007
2. Uses		-	363	421	452	470	595	447	253	390	072	058	002	019	001
3. Similarities			-	314	429	148	160	607	180	199	028	055	014	019	017
4. Pattern Meanings				-	741	-014	088	283	611	446	084	067	086	017	059
5. Line Meanings					-	107	241	266	381	632	119	090	084	087	114
Uniqueness Scores:															
6. Names						-	533	405	080	278	015	-096	-011	064	090
7. Uses							-	444	307	457	219	109	117	152	141
8. Similarities								-	212	315	027	047	058	097	111
9. Pattern Meanings									-	469	204	148	082	094	112
10. Line Meanings										-	192	191	044	025	002
Intelligence Scores:															
11. AL (verbal)											-	640	575	562	482
12. AQ (numerical)												-	305	388	319
13. Vocabulary													-	736	636
14. Speed of Comprehension														-	867
15. Level of Comprehension															-

Note.--Decimal points omitted. With df = 122, critical values of the correlation coefficient are .227 ($p < .01$), and .175 ($p < .05$).

Table 4.3.2

Cropley's Principal Axis Factor Loadings
(Decimal points omitted.)

Variables	Factor				
	I	II	III	IV	h^2
Fluency Scores:					
1. Names	369	-366	-520	-079	547
2. Uses	731	-362	-211	-062	713
3. Similarities	588	-289	104	-594	793
4. Pattern Meanings	646	-202	587	-193	841
5. Line Meanings	690	-174	446	-042	707
Uniqueness Scores:					
6. Names	472	-272	-685	164	792
7. Uses	636	-100	-385	401	723
8. Similarities	617	-227	-200	-295	559
9. Pattern Meanings	557	-031	439	299	594
10. Line Meanings	667	-171	237	457	739
Intelligence Scores:					
11. AL (verbal)	413	690	007	212	692
12. AQ (numerical)	315	538	108	231	454
13. Vocabulary	332	755	-060	-161	709
14. Speed of Comprehension	376	810	-176	-184	862
15. Level of Comprehension	369	744	-176	-220	768
Sums of squares	4.32	3.13	1.85	1.18	10.48
% total variance	28.80	20.87	12.33	7.87	69.87
% common variance	41.22	29.87	17.65	11.26	100.00

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UNIQUE VARIANCES

0.611	0.396	0.775	0.195	0.304	0.308	0.507	0.652	0.623	0.565
0.641	0.819	0.425	0.041	0.223					

VARIMAX-ROTATED FACTOR MATRIX

FLUENCY SCORES:			
1. Names	−0.095	0.087	0.610
2. Uses	−0.011	0.441	0.640
3. Similarities	0.012	0.387	0.274
4. Pattern Meanings	0.048	0.896	0.009
5. Line Meanings	0.104	0.813	0.156
Uniqueness Scores:			
6. Names	0.011	−0.033	0.831
7. Uses	0.125	0.165	0.671
8. Similarities	0.076	0.296	0.504
9. Pattern Meanings	0.115	0.597	0.085
10. Line Meanings	0.028	0.570	0.331
INTELLIGENCE SCORES:			
11. AL (verbal)	0.589	0.101	0.039
12. AQ (numerical)	0.411	0.106	−0.031
13. Vocabulary	0.757	0.041	−0.024
14. Speed of Compre.	0.976	−0.034	0.063
15. Level of Compre.	0.879	−0.000	0.071

Table 4.3.3.: Cropley's Australian Study, (UMLFA 3 Factor Solution)

UNIQUE VARIANCES

0.386	0.373	0.819	0.0	0.393	0.323	0.259	0.665	0.511	0.492
0.557	0.747	0.415	0.044	0.213					

VARIMAX-ROTATED FACTOR MATRIX

FLUENCY SCORES:				
1. Names	0.073	−0.123	0.755	− 0.152
2. Uses	0.415	−0.014	0.619	0.266
3. Similarities	0.302	0.003	0.295	0.053
4. Pattern Meanings	0.987	0.025	0.077	− 0.136
5. Line Meanings	0.748	0.093	0.171	0.097
UNIQUENESS SCORES:				
6. Names	−0.048	0.011	0.795	0.205
7. Uses	0.138	0.156	0.502	0.667
8. Similarities	0.282	0.080	0.442	0.232
9. Pattern Meanings	0.647	0.123	0.008	0.234
10. Line Meanings	0.499	0.044	0.202	0.465
INTELLIGENCE SCORES:				
11. AL (verbal)	0.107	0.609	− 0.054	0.240
12. AQ (numerical)	0.096	0.429	− 0.116	0.217
13. Vocabulary	0.071	0.761	− 0.037	0.002
14. Speed of Compre.	−0.022	0.973	0.082	− 0.055
15. Level of Compre.	0.014	0.873	0.116	− 0.106

Table 4.3.4: Cropley's Australian Study, (UMLFA 4 Factor Solution)

principal components factor analysis and did not rotate the solution. He thus retains a general factor in spite of the fact that the intercorrelations between the creativity and intelligence tests are very small in comparison with the correlations within each domain. His second and third factors are bipolar and not very amenable to interpretation in the domain of human abilities. I have performed an unrestricted maximum likelihood factor analysis of Cropley's correlation matrix with a Varimax rotation. The solution for three factors is given in Table 4.3.3. The first factor is clearly an intelligence factor. Factors II and III are creativity factors; II is the "visual" factor, and III resembles the "verbal" factor with some difficulty caused by the Names test. Cropley did not seem to be aware of the substructure in the tests, or at least, he does not refer to it. I present the four factor solution for completeness sake in Table 4.3.4. The interesting finding here is that on the first factor, the "creativity-visual" factor, the Names test loads very poorly whereas the Uses and Similarities tests have moderate loadings. In the present research study, I have followed the lead of Wallach and Wing and deleted the Names test.

4.4 The Cropley and Maslany Canadian Study

In 1969, Cropley and G. W. Maslany (University of Saskatchewan) administered the Wallach and Kogan materials to 207 Canadian university students, of both sexes, and having a mean age of 20 years, 3 months. In this study, the authors administered the tests in an informal group atmosphere. Students were allowed to smoke, drink coffee, and move about the room. No time limits were imposed. Total times ranged from 1 hour 15 minutes to 6 hours 30 minutes (median was 3 hours). In addition, Cropley and Maslany administered six tests

from the Primary Mental Abilities battery. In scoring the creativity items, the authors did not score for number and uniqueness. Instead, they scored for originality, the latter being defined in terms of statistical uncommonness. Scores ranged from 0 for a response occurring on more than 15% of the protocols to a maximum of 4 for a truly unique response. This, it seems to me, is a reasonable approach. However, it still entails calculating all of the percentages of each response. I found this to be an extremely tedious and often difficult task as will be explained in the consideration of scoring the materials in the present research. Therefore, it would have been helpful if Cropley and Maslany had continued to use the more or less current system of scoring. If the high correlations between uniqueness scores and number scores could be verified in a few more studies with the concurrent absence of any separate number and uniqueness factors, I think it could be shown that the uniqueness score could simply be ignored. Theoretically this may sound somewhat damaging as the ordinary concept of creativity seems to imply this certain cleverness that should show up in responses that are unique. Nevertheless, the empirical evidence seems to show that it adds little to what is already provided by the productivity measures.

The correlation matrix for the Cropley and Maslany study is reproduced in Table 4.4.1. Their factor analysis is reproduced in Table 4.4.2. As in the previous study, it allows for rather poor psychological interpretation. Realizing this, Kogan, in 1971, refactored the Cropley and Maslany correlation matrix using the Promax method of Hendrickson and White (1964). I include it in Table 4.4.3 for comparison with the unrestricted maximum likelihood solution which is given for three factors in Table 4.4.4. The UMLFA

Table 4.4.1

(Cropley and Maslany)

Means, Standard Deviations, and Intercorrelations

for All Variables (N = 207)

Variable	1	2	3	4	5	6	7	8	9	10	11
Mean	40.8	43.4	28.1	70.0	48.7	28.1	21.7	13.7	21.2	11.0	38.6
S.D.	28.3	23.8	20.6	32.5	25.5	7.47	4.69	3.88	3.42	3.42	10.5
1. Names	-	625	402	321	267	168	084	155	142	157	093
2. Uses		-	690	474	366	140	119	070	189	107	200
3. Similarities			-	456	425	038	043	-065	086	-033	137
4. Pattern meanings				-	742	-026	027	017	082	-047	164
5. Line meanings					-	-070	-027	-015	027	006	075
6. Verbal meaning						-	206	263	461	126	164
7. Number facility							-	280	409	291	330
8. Letter series								-	368	362	220
9. Word groupings									-	166	217
10. Number series										-	289
11. Spatial relations											-

Note.--For 205 df, r's of .14 and .18 are significant at the .05 and .01 levels, respectively. Decimal points omitted in correlation coefficients.

Table 4.4.2

Cropley and Maslany's Principal Axis Factor Loadings

(All decimal points omitted in factor loadings.)

VARIABLES	FACTORS I	FACTORS II	FACTORS III	h^2
1. Names	673	-101	252	530
2. Uses	792	-203	180	702
3. Similarities	668	-378	124	605
4. Pattern Meanings	685	-441	-202	705
5. Line Meanings	604	-476	-262	660
6. Verbal Meaning	305	508	559	661
7. Number Facility	344	571	-191	481
8. Letter Series	307	599	-108	465
9. Word Grouping	431	566	314	605
10. Number Series	276	505	-455	538
11. Spatial Relations	416	365	-440	500
Sums of Squares	3.10	2.26	1.07	6.43
Total Variance (%)	28.2	20.5	9.73	58.4
Common Variance (%)	48.2	35.1	16.8	100.0

Table 4.4.3

Kogan's Promax Rotation of Cropley and Maslany's Principal Axis Solution (1969)

Variables	Factors		
	I	II	III
Names	627	-068	350
Uses	810	-049	272
Similarities	801	-147	111
Pattern Meanings	803	123	248
Line Meanings	752	128	341
Verbal Meaning	-007	-035	815
Number Facility	-036	602	219
Letter Series	-082	549	288
Word Grouping	056	235	663
Number Series	-066	743	-053
Spatial Relations	128	694	-081

Note: All decimal points are omitted.

<u>Factor Correlations</u>

	I	II	III
I	1.000	0.124	0.068
II	0.124	1.000	0.286
III	0.068	0.286	1.000

Table 4.4.4

(Cropley and Maslany)

Maximum Likelihood Solution for Three Factors

Unique Variances										
1	0.599	0.0	0.474	0.272	0.222	0.743	0.674	0.661	0.567	0.807
	0.804									

Varimax-Rotated Factor Matrix

1	0.587	0.152	0.184
2	0.974	0.173	0.149
3	0.655	0.312	-0.012
4	0.344	0.780	0.026
5	0.230	0.851	-0.037
6	0.083	-0.081	0.493
7	0.036	-0.005	0.569
8	-0.019	0.008	0.582
9	0.088	0.038	0.651
10	0.049	-0.030	0.435
11	0.124	0.101	0.413

technique captures the substructure of the creativity dimension very nicely. Factor 1 appears to be a "creativity-verbal" factor, II a "creativity-visual" factor, and III an intelligence factor.

4.5 Wallach and Wing's Duke University Study

In 1969, Michael Wallach and Cliff Wing published the results of a study they conducted using the Wallach and Kogan materials but deleting the Names Test. Wallach and Wing mailed the creativity materials to the entering class at Duke University and invited the students to participate in the research study. About 40% of the students (302 men, 201 women) agreed to participate. They used the Scholastic Aptitude Tests as their intelligence measures.

Before examining the correlation matrix from their study, it would be appropriate to consider several important points that Wallach and Wing stress. In defending the use of both uniqueness scores and productivity scores (Maslany and Cropley, in their Canadian Study, combined these into one), Wallach and Wing reason as follows:

> Recall that we wished to compare the psychological implications of ideational output and ideational uniqueness, since the two cognitive characteristics suggested different underlying mechanisms. Hence, an approach was needed that would maximize the potential separation between the two. By defining uniqueness in terms of the number of fully unique responses, we provided as much of an opportunity as possible for the uniqueness count to diverge from the measure of total number of ideas produced.

This seems to be a reasonable theory, and one which can be checked by extracting factors. All of the preceding analyses, and those which will be presented in the following, seem to indicate rather clearly that the number-uniqueness structure is not nearly as important as the verbal-visual structure. Wallach and Wing seem to ignore this point. In extracting four factors from the

creativity correlation matrix for items in my own research, I found that the two substructures, verbal and visual, break down into uses, similarities, lines, and patterns factors with no evidence of number and uniqueness factors.

Unfortunately, Wallach and Wing do not report the complete correlation matrix for their tests. They state that the correlations between uniqueness and number on a single test would be subject to artifactual inflation. It would have been interesting to see if that was the case. At any rate, in order to perform a factor analysis of these data, I assumed that the correlation between the number and the uniqueness on any subtest would be at least as high as the correlation between the number on that subtest and the uniqueness on a different subtest. This would seem to be a fair compromise, and, if anything, an underestimate of the actual correlation. Of course, the greater this correlation, the better will be the chances of finding the substructure that has been hypothesized. Thus, for the correlation between number of uses and uniqueness of uses I used the correlation between number of uses and uniqueness of patterns; for similarities, I used patterns; for patterns, I used lines; and, finally, for lines, I used patterns. The correlation table is reproduced in Table 4.5.1 with the added correlations underlined. Wallach and Wing reported a correlation of .380 between SAT-V and SAT-M. The two and three factor solutions are given in Tables 4.5.2 and 4.5.3. Even though Wallach and Wing have only the two intelligence measures, the structure is quite clear. The fact that there are eight creativity measures and only two intelligence measures results in the creativity substructure appearing first. In the two factor solution, the first factor is the "creativity-verbal" factor, the second is the "creativity-figural" factor. In the three factor

Table 4.5.1

(Wallach and Wing)

Correlations and Intercorrelations of Creativity

and Intelligence Variables

	Variable	1	2	3	4	5	6	7	8	9	10
1.	Uses-fluency		55	71	48	59	55	57	46	08	-02
2.	Uses-unique			54	51	37	43	36	38	08	05
3.	Similarities-fluency				58	66	58	67	52	03	-03
4.	Similarities-unique					43	49	36	37	03	-03
5.	Patterns-fluency						66	79	66	03	-07
6.	Patterns-unique							63	70	05	-03
7.	Line Meanings-fluency								63	08	-05
8.	Line Meanings-unique									09	-03
9.	SAT-Verbal										38
10.	SAT-Mathematical										

Note.--For 501 df, r's of .09 and .12 are significant at the .05 and .01 levels, respectively. Decimal points are omitted.

From The Talented Student by M. Wallach and C. Wing. New York: Holt, Rinehart, and Winston, 1969.

1	0.370	0.477	0.264	0.523	0.191	0.414	0.237	0.449	0.994	0.990

VARIMAX-ROTATED FACTOR MATRIX

0 10 2 503 5 5

1	0.730	0.312
2	0.721	0.048
3	0.754	0.409
4	0.680	0.121
5	0.480	0.761
6	0.536	0.547
7	0.452	0.747
8	0.423	0.610
9	0.077	0.018
10	0.028	-0.097

Table 4.5.2: Wallach and Wing (UMLFA 2 Factor Solution)

1	0.370	0.479	0.258	0.519	0.190	0.414	0.235	0.443	0.429	0.737

VARIMAX-ROTATED FACTOR MATRIX

0 10 3 503 5 7

1	0.465	0.027	0.643
2	0.210	0.081	0.686
3	0.560	-0.037	0.654
4	0.264	-0.017	0.641
5	0.844	-0.059	0.307
6	0.653	0.004	0.400
7	0.830	0.002	0.276
8	0.693	0.041	0.272
9	0.082	0.751	0.019
10	-0.061	0.509	0.016

Table 4.5.3: Wallach and Wing (UMLFA 3 Factor Solution)

structure, the intelligence factor appears. The evidence for a uniqueness-productivity substructure is weak, certainly much weaker than the verbal-figural substructure.

4.6 Summary

These studies provide rather good evidence for the intelligence-creativity distinction using the Wallach and Kogan measures as the measures of creativity. In addition, the evidence for the interpretable substructure appears to be fairly good. In the research study to be reported in the next chapter, the use of the materials with a high school sample will be tested. The creativity measures will also be related to many more intelligence and achievement measures than have been reported in the literature thus far.

CHAPTER 5

XAVERIAN HIGH SCHOOL SAMPLE: MEASURES AND HYPOTHESES

5.1 Introduction

The studies reviewed in the preceding chapters provide rather strong evidence that the measures obtained with the Wallach and Kogan materials are coherent, have a meaningful substructure, and are independent of at least some common measures of intelligence. The materials have been used with children between the ages of four and eleven. They have been used with college students under two different testing conditions: a relaxed group condition in the Cropley and Maslany studies, and testing by mail in the Wallach and Wing study.

In the present research study, the Wallach and Kogan materials were administered to a group of high school sophomores in an attempt to extend their use to the middle age level. In addition, many more measures of intelligence and achievement have been added to those reported in previous studies.

5.2 Design of the Study

A variety of factors entered into the choice of the sample to be used in this research study. One of the main considerations was to use students between the ages of 11 and 18 in order to extend the use of the creativity materials. In addition, it was desirable to obtain intelligence information on the students. It was felt that such information would be readily available at the secondary school level. Accordingly, the principal at Xaverian High School in Brooklyn, New York, was contacted by the researcher and clearance

to test students at any level in the school was obtained. The testing was to be carried out during the summer or fall of 1969. It was decided that the class which would begin its junior year in September, 1969 would be the most appropriate group to test for they would take the Preliminary Scholastic Aptitude Test at the beginning of their junior year, the National Merit Scholarship Qualifying Test in March, and the college board examination (SAT) at the end of the junior year. As a result, a good deal of intelligence information could be gathered.

The next consideration was whether to administer the tests in school or to mail them to the students. It would be difficult to convince high school students in a classroom setting that they were to relax and not be concerned about the evaluative aspects of the testing. Nathan Kogan, in some recent unpublished research, found this to be the case. Therefore, the students were tested by mail. It was hoped that this would also allow the students more freedom in deciding whether or not to participate in the study. This freedom to participate probably accounts for the fact that those students who did participate filled out the materials seriously. Obscene, vulgar, and bizarre responses were virtually nonexistent.

Once the decision to test by mail was made, it was decided that a summer testing would be more apt to keep the students from sharing responses. Xaverian High School's student body comes from a large geographical region in New York City. The summer mailing was about as good a control over sharing responses as could be attained.

Thus, the original design of the study was to test during the summer of 1969 as many of the Xaverian High School sophomores as would volunteer to

participate in the study. If a sufficient number agreed to participate, the intelligence measures would be obtained at a later date from the school.

5.3 Instruments and Procedure

In August of 1969, the Wallach and Kogan materials were mailed to the homes of the 371 sophomores. The students were informed that, with the principal's permission, they were being asked to participate in a research study of some new educational materials. They were assured that their responses would be kept strictly confidential. In addition, they were told that the researcher would visit the school during the course of the year to explain the research further and to invite them to continue their participation. Subsequently, this was done. The students were asked to return the materials by August 31st. One hundred forty students returned the materials completed and volunteered to participate in the research study.

During the next few months it became evident that the scoring of the 140 tests would be a rather formidable task. It was decided to select a random sample of 40 students for a preliminary analysis. Using these 40 students and the Preliminary Scholastic Aptitude Test administered in October 1969, a preliminary analysis was performed and reported in the Minor Research Report A Validation of the Creativity-Intelligence Distinction in High School Sophomores (June 1970). The preliminary analysis was encouraging, and the decision was made to analyze the data of all 140 students and to gather other available intelligence and achievement information. The actual measures used in the total study will be described in the following sections.

5.4 The Creativity Measures

The actual materials sent to the high school students are reproduced in Appendix 1. The items are taken from the original Wallach and Kogan materials (1965a) and comprise four tests: a Uses Test, a Similarities Test, a Pattern Meanings Test, and a Line Meanings Test. Each test contains three items.

Two scores are obtained for each item, a productivity score and a uniqueness score. The productivity score is simply the number of distinct responses given for an item. A unique response is one that is given by only one subject in the sample. The uniqueness score for an item is the number of unique responses given for that item. While the productivity score is obtained easily, the uniqueness score presents a number of difficulties. The actual procedure used in this study for the productivity scores was to reproduce two sets of the student materials and have independent scorers score them. Disagreements were resolved by the author usually in favor of the higher score. Since the students were directed to give distinct responses, this seemed to be a reasonable approach. Unique scores were determined by the author with assistance from several students in psychology. In general, the following principles outlined by Wallach and Wing in <u>The Talented Student</u> were used in the scoring:

(1) Different terms which have the same meaning are considered to be the same. For example, "toy" and "plaything" are categorized as the same use for a shoe.

(2) Singular and plural responses are considered to be the same in the case of the verbal items. For instance, "line garbage can" and "line garbage cans" are categorized as the same use

for a newspaper. In the case of the visual items, on the other hand, singular and plural responses are not considered to be the same because different images are involved: the student envisions a different percept in each case.

(3) Such phrases as "part of," "piece of," or "article of," are treated as irrelevant when they refer to a collective concept. For example, "piece of string" and "string" are categorized as the same response for the second item in the line meanings task. The aforementioned kind of phrases are retained as meaningful, however, when they refer to a discrete concept, because different images are envisioned. For instance, "part of a racetrack" and "racetrack" are categorized as different responses for the second item in the pattern meanings task.

(4) References to the position of the viewer are treated as irrelevant. For instance, "upside-down vase" and "vase" are classified as the same response for the third item in the line meanings task.

(5) Qualifiers representing varying degrees of endorsement are considered to be the same. For example, in relation to similarities between a potato and a carrot, the following responses are taken as equivalent: "always peeled," "usually peeled," "often peeled," "normally peeled," "sometimes peeled," and "peeled." Analogously, qualifiers representing varying degrees of nonendorsement are considered

	LABEL	MEAN	VARIANCE	S.D.	LOW	HIGH	ID of HIGHEST SCORING STUDENT
1	NUSES1	15.66	176.08	13.27	3.00	90.00	L353
2	NUSES2	8.13	33.48	5.79	1.00	44.00	L100
3	NUSES3	7.30	30.13	5.49	1.00	32.00	L100
4	NPAT1	6.42	76.52	8.75	1.00	99.00	L100
5	NPAT2	6.05	50.02	7.07	0.0	76.00	L100
6	NPAT3	4.27	21.26	4.61	0.0	46.00	L100
7	NSIM1	7.81	33.71	5.81	0.0	52.00	L100
8	NSIM2	6.94	31.05	5.57	1.00	48.00	L100
9	NSIM3	5.86	21.42	4.63	0.0	31.00	L100
10	NLIN1	6.47	22.34	4.73	0.0	46.00	L100
11	NLIN2	5.22	17.01	4.12	0.0	33.00	L100
12	NLIN3	5.82	31.51	5.61	1.00	60.00	L100
13	UUSES1	0.76	4.13	2.03	0.0	18.00	L100
14	UUSES2	0.72	3.17	1.78	0.0	17.00	L100
15	UUSES3	0.67	2.22	1.49	0.0	12.00	L100
16	UPAT1	1.84	51.58	7.18	0.0	84.00	L100
17	UPAT2	1.44	19.17	4.38	0.0	49.00	L100
18	UPAT3	1.52	9.32	3.05	0.0	32.00	L100
19	USIM1	0.67	2.47	1.57	0.0	14.00	L100
20	USIM2	0.55	1.72	1.31	0.0	9.00	L100
21	USIM3	0.62	2.35	1.53	0.0	15.00	L155
22	ULIN1	1.04	8.37	2.89	0.0	31.00	L100
23	ULIN2	1.53	6.47	2.54	0.0	21.00	L100
24	ULIN3	1.43	11.38	3.37	0.0	37.00	L100

Table 5.4.1: Creativity Scores (N=140)

to be the same. For instance, the following responses are taken as equivalent similarities for train and tractor; "never colored white," "seldom colored white," and "not colored white."

The means, standard deviations, high and low scores, and the identifying number of the students obtaining the highest scores are listed in Table 5.4.1 for each of the 12 items. The reason for including the student with the highest score will be apparent from the discussion in the next section.

5.5 The Problem of Student Number 100

After the raw creativity scores were obtained, the correlation matrix shown in Table 5.5.1 was computed. These correlations were sufficiently high to indicate good item-item interrelationships and to justify adding the items on a given subtest together. In order that each item would contribute equally to total scores, all item scores were standardized with a mean of zero and a standard deviation of one. When these standardized scores were examined, it was immediately evident that the scores of student number 100 were extremely deviant. It can be seen from Table 5.4.1 that student number 100 scored highest on 22 of the 24 creativity measures. In reexamining the original test for student number 100, it was found that his scores were correct. They were simply very deviant. The actual standard scores for this student were more than four standard deviations from the mean on every measure and more than nine standard deviations on ten of the measures. Since the sample size is 140, the effect of student number 100's scores on the entire data is not immediately evident.

POSITION	LABEL	1 NUSES1	2 NUSES2	3 NUSES3	4 NPAT1	5 NPAT2	6 NPAT3	7 NSIM1	8 NSIM2	9 NSIM3	10 NLIN1	11 NLIN2	12 NLIN3	13 UUSES1	14 UUSES2	15 UUSES3	16 UPAT1	17 UPAT2	18 UPAT3
1	NUSES1	100	66	62	43	45	44	59	50	40	38	36	47	71	44	45	39	39	44
2	NUSES2	66	100	77	61	67	62	65	68	56	52	51	61	61	77	63	58	55	60
3	NUSES3	62	77	100	56	58	59	71	68	62	47	51	56	53	54	72	46	48	54
4	NPAT1	43	61	56	100	95	91	74	76	61	84	74	90	71	75	72	95	92	92
5	NPAT2	45	62	58	95	100	91	71	73	64	85	78	89	69	71	68	90	92	91
6	NPAT3	44	62	59	91	91	100	77	81	72	84	79	90	64	67	63	84	84	92
7	NSIM1	59	65	71	74	71	77	100	88	75	68	66	76	63	61	68	69	66	69
8	NSIM2	50	68	68	76	73	81	88	100	83	70	62	76	57	61	67	68	65	70
9	NSIM3	40	56	62	61	64	72	75	83	100	64	64	67	45	47	55	52	54	60
10	NLIN1	38	52	47	84	85	84	68	70	64	100	83	85	56	59	53	76	78	78
11	NLIN2	36	51	51	74	78	79	66	62	64	83	100	80	50	53	51	63	67	73
12	NLIN3	47	61	56	90	89	90	76	76	67	85	80	100	69	69	63	85	84	86
13	UUSES1	71	61	53	71	69	64	63	57	45	56	50	69	100	62	61	74	70	72
14	UUSES2	44	77	54	75	71	67	61	61	47	59	53	69	62	100	64	78	74	72
15	UUSES3	45	63	72	72	68	63	68	67	55	53	51	63	61	64	100	69	65	64
16	UPAT1	39	58	46	95	90	84	69	68	52	76	63	85	74	78	69	100	94	90
17	UPAT2	39	55	48	92	92	84	66	65	54	78	67	84	70	74	65	94	100	88
18	UPAT3	44	60	54	92	91	92	69	70	60	78	73	86	72	72	64	90	88	100
19	USIM1	52	63	58	74	72	72	86	78	66	66	62	74	66	65	64	74	72	69
20	USIM2	37	53	58	64	63	67	75	83	72	52	49	61	48	48	60	60	56	61
21	USIM3	30	35	44	36	38	42	60	59	65	33	35	38	37	26	46	32	33	36
22	ULIN1	37	55	47	89	87	82	70	68	58	84	72	84	65	71	63	89	90	85
23	ULIN2	32	49	45	74	75	72	62	59	57	73	84	75	54	55	55	69	71	72
24	ULIN3	39	57	50	92	88	88	75	74	62	79	74	91	70	73	65	92	89	88

Table 5.5.1: Correlations of the Creativity Scores (N = 140)

POSITION	LABEL	19 USIM1	20 USIM2	21 USIM3	22 ULIN1	23 ULIN2	24 ULIN3
1	NUSFS1	52	37	30	37	32	39
2	NUSFS2	63	53	35	55	49	57
3	NUSFS3	58	58	44	47	45	50
4	NPAT1	74	64	36	89	74	92
5	NPAT2	72	63	38	87	75	88
6	NPAT3	72	67	42	82	72	88
7	NSIM1	86	75	60	70	62	75
8	NSIM2	78	83	59	69	59	74
9	NSIM3	66	72	65	59	57	62
10	NLIN1	66	52	33	84	73	79
11	NLIN2	62	49	35	72	84	74
12	NLIN3	74	61	39	84	75	91
13	UUSFS1	66	48	37	65	54	70
14	UUSFS2	65	48	26	71	55	73
15	UUSFS3	64	60	46	63	55	65
16	UPAT1	74	60	32	89	69	92
17	UPAT2	72	56	33	90	71	89
18	UPAT3	69	61	36	85	72	88
19	USIM1	100	70	68	76	62	73
20	USIM2	70	100	68	57	51	65
21	USIM3	68	68	100	38	33	38
22	ULIN1	76	57	38	100	76	86
23	ULIN2	62	51	33	76	100	75
24	ULIN3	73	65	38	86	75	100

Table 5.5.1 (cont'd)

In order to determine whether or not the scores in question would inordinately distort the results of this study, several factors were considered. First of all, it is desirable to justify adding the scores on individual items together in order to obtain total scores on subtests. High interitem correlations are ordinarily used as evidence for the reasonableness of this process. In addition, the substructure of the creativity dimension would be determined by factor analyzing the correlation matrix. Therefore, the correlations are the primary data to be analyzed in this research study. What effect would one student's scores have on the correlation coefficients in the study? The answer to this question was used to justify the decision to delete student number 100's scores from the data before proceeding. Nevertheless, in Appendix 2, a two factor UMLFA solution for N = 140 is presented for comparison.

5.6 Influence of a Deviant Score on the Correlation Coefficient

There is no absolutely agreed upon criterion for deleting a deviant score from a set of data. However, there are ways of assessing its effects. In this section, three approaches will be considered to justify deleting student number 100's scores from the data before proceeding:

(1) Consideration of the scatter plots of the data

(2) Consideration of the variance in the data

(3) Consideration of the changes in the correlation coefficients when #100 is deleted.

(1) The scatter plots for several measures are given in Figures 5.6.1 through 5.6.4. Each scatter plot resembles a case in which many scores are

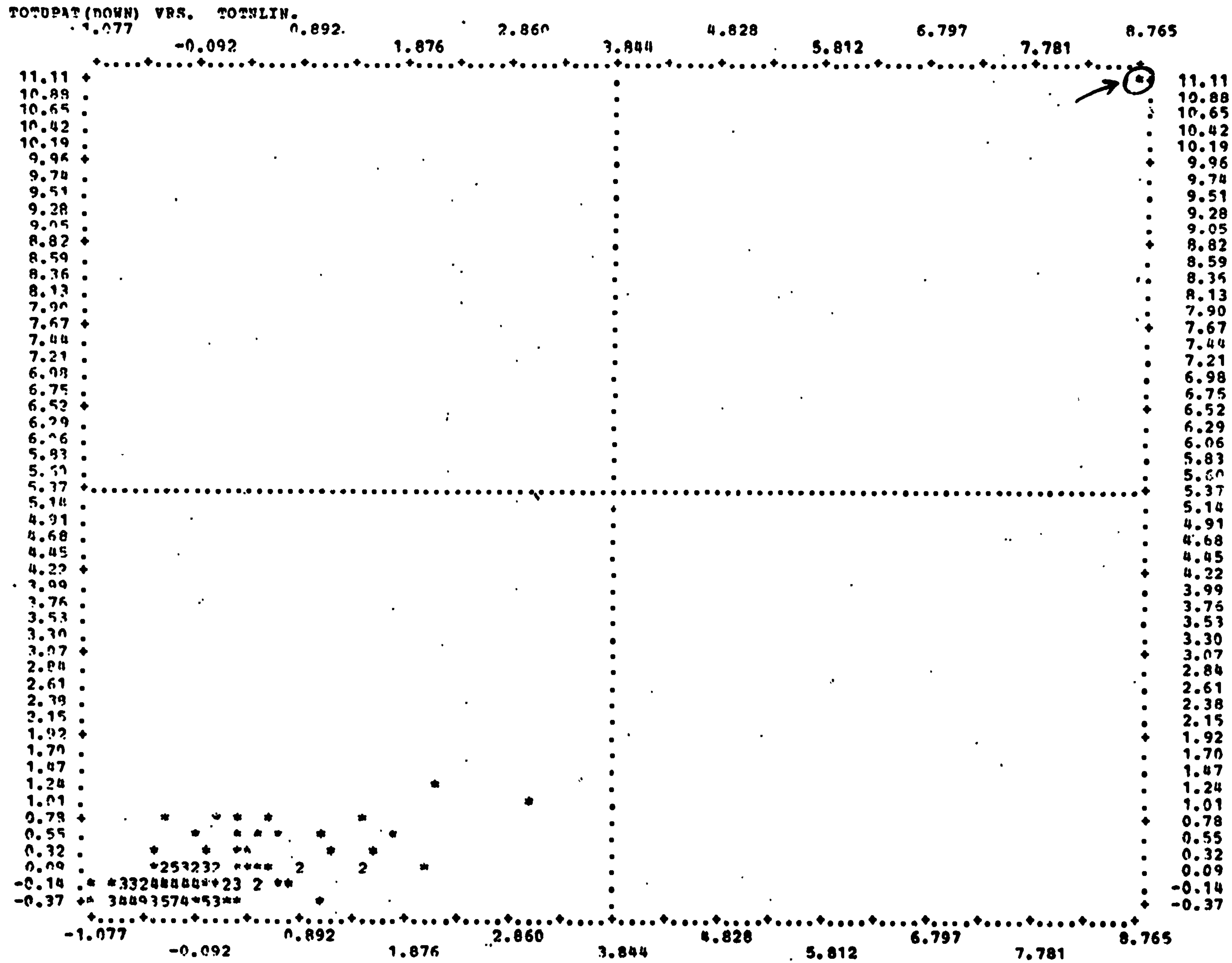

Figure 5.6.1 (N=140)

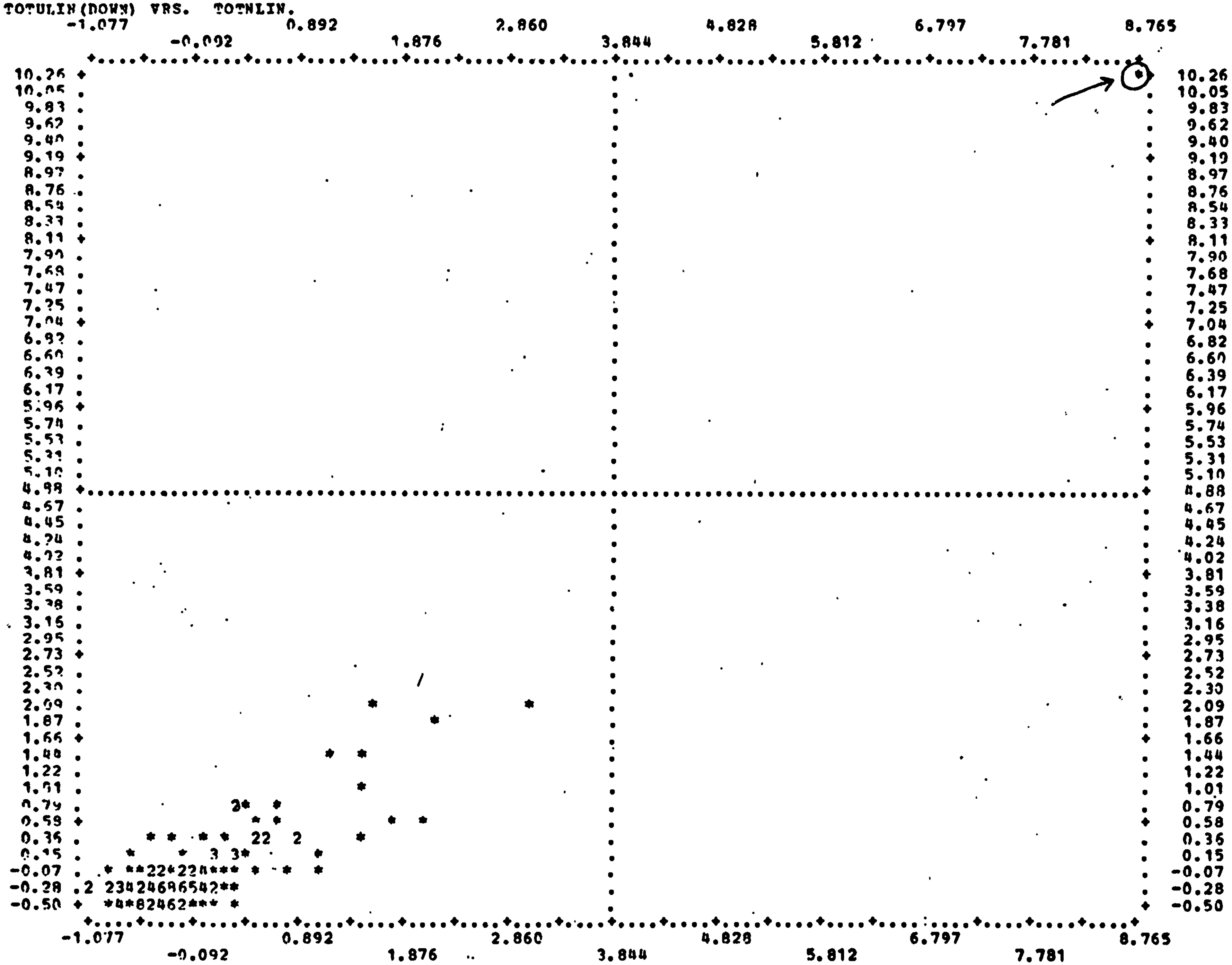

Figure 5.6.2 (N=140)

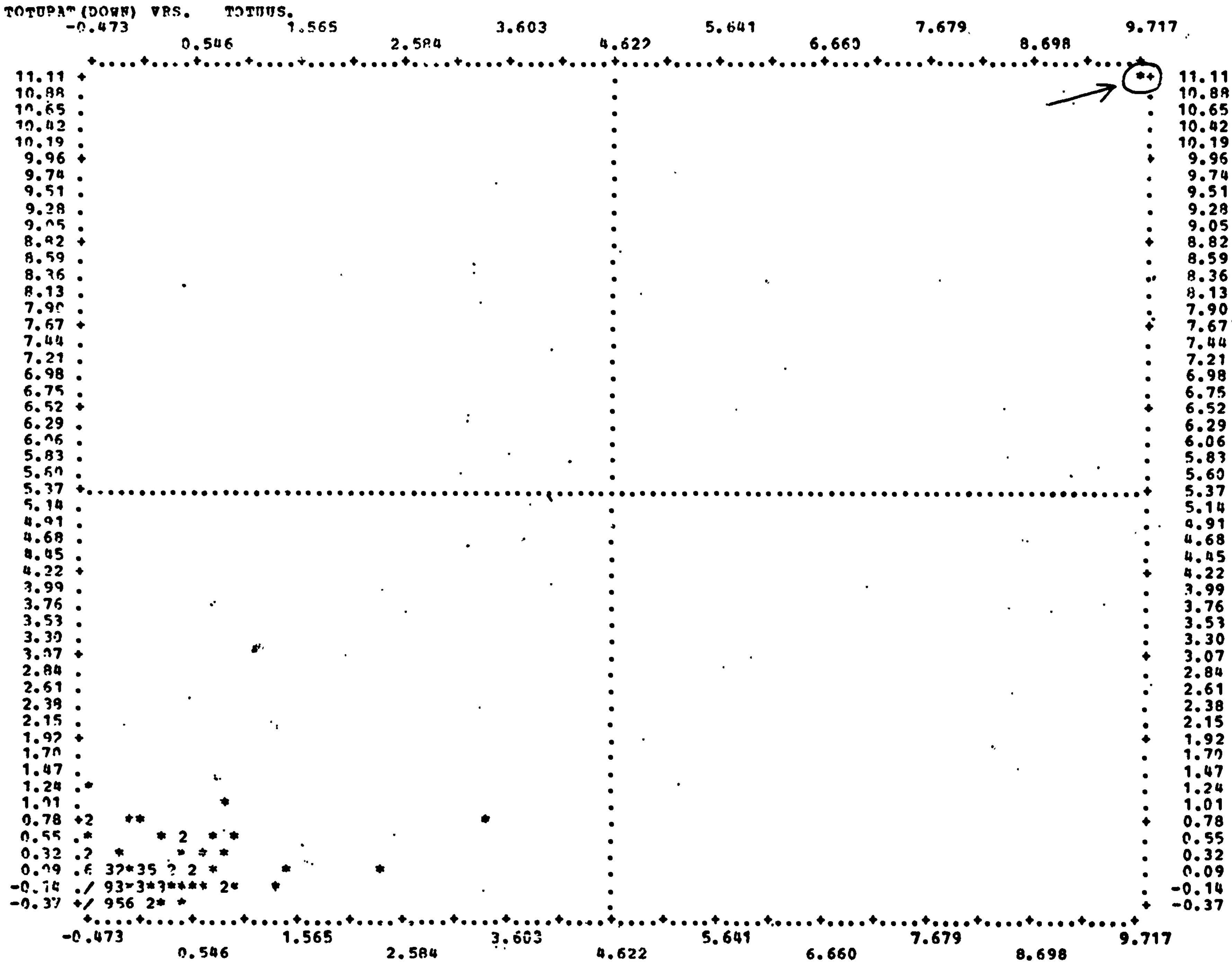

Figure 5.6.3 (N=140)

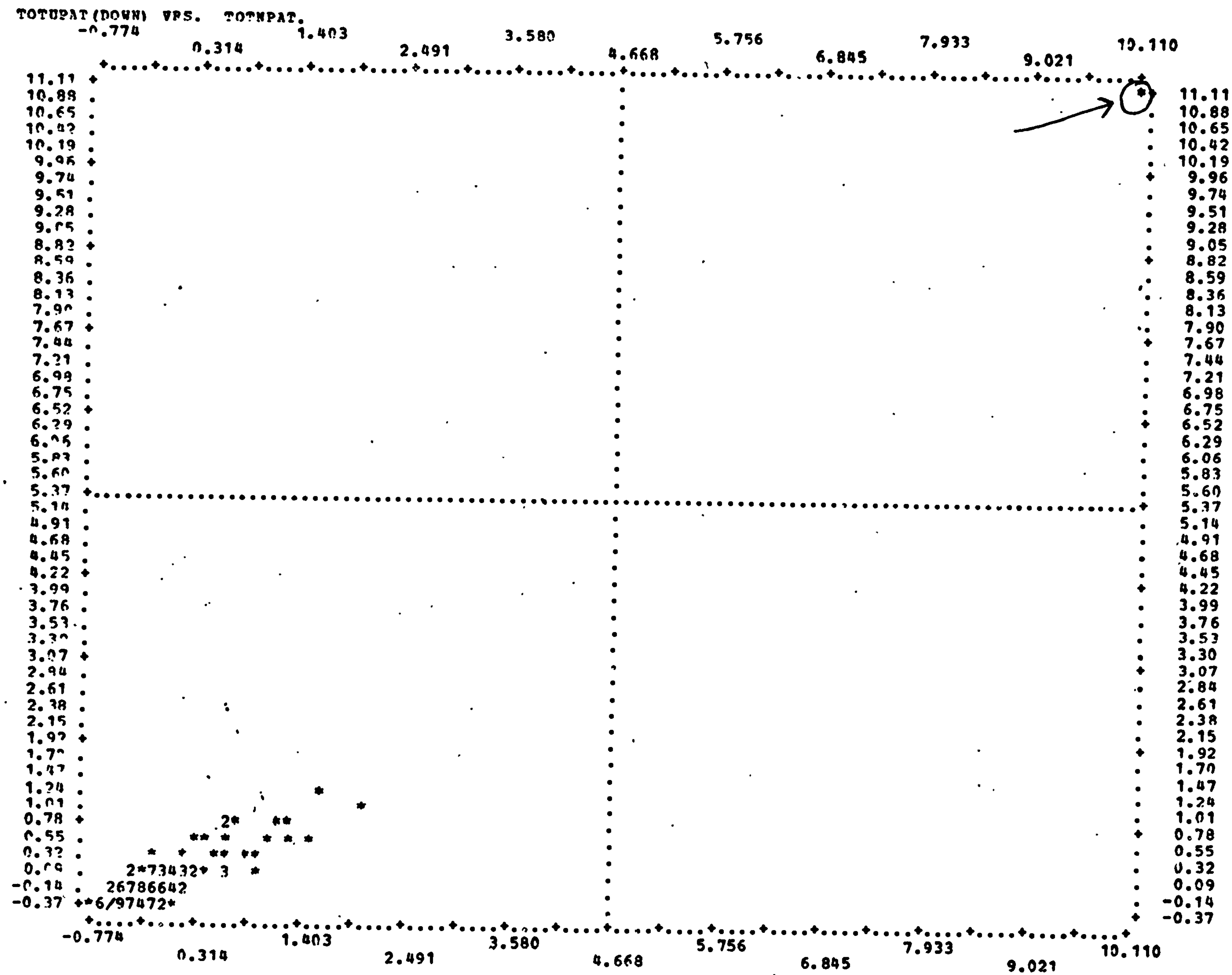

Figure 5.6.4 (N=140)

close to the origin and one score is large. In order to demonstrate the effect of a deviant score on data like this, consider the following case. Suppose that four students score as follows on two items: (1, 1), (1, 2), (2, 1), and (2, 2). The mean score on each item would be 1.50, the standard deviation would be .58 and the correlation is zero. Now, if a fifth student scored (10, 10), the mean would become 3.20 and the standard deviation 3.83. The correlation coefficient would become .98. That such a large change occurs is probably not surprising since the one student in only five would seem rather critical. Now, assume that instead of one student receiving each of the (1, 1), (1, 2), (2, 1), and (2, 2) scores, 50 students receive each of those scores, thus raising the N involved to 200 students. What would be the effect of one student receiving a score of (10, 10) on the two items? For N = 200, the mean, standard deviation, and correlation coefficient would still be 1.50, .58, and 0.0, respectively. With N = 201, the mean would be 1.54 and the standard deviation .78. At face value these changes may seem rather small. Nevertheless, the correlation coefficient would now be .59. For an N of 201, this value is significantly different from zero. Yet it is a spurious value. A scatterplot of these data would look like Figure 5.6.5.

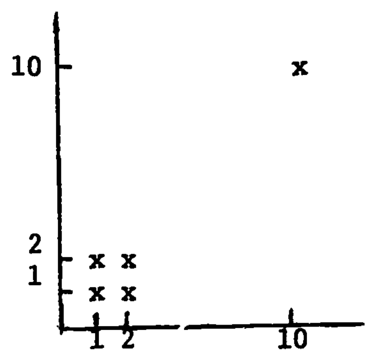

Fig. 5.6.5

The scatterplots given in Figures 5.6.1 through 5.6.4 indicate that the data in this research are similar to that given in this example. The scatterplots with student number 100 deleted are given in Figures 5.6.6 through 5.6.9.

(2) Harold Gulliksen (Theory of Mental Tests, 1950) and Quinn McNemar (Psychological Statistics, 1962) give the following equation relating the correlation between two variables in a curtailed sample with the correlation of the two variables in the uncurtailed sample and the standard deviations in both samples:

$$R_{xy} = \frac{r_{xy}\left(\frac{SD_x}{sd_x}\right)}{\sqrt{1 - r_{xy}^2 + r_{xy}^2\left(\frac{SD_x}{sd_x}\right)^2}}$$

where R_{xy} = correlation with uncurtailed range,

r_{xy} = correlation with curtailed range,

SD_x = standard deviation with uncurtailed range,

sd_x = standard deviation with curtailed range.

It is evident from this formula that the ratio of the standard deviations is an important factor in accounting for the change in a correlation coefficient when the range of the variables is curtailed. Ordinarily, the deletion of a single score will not cause a very large change in the ratio of the standard deviations. In the data at hand, however, the deletion of the scores of student number 100 causes rather large changes in the ratio of the standard deviations (see for example NPAT1 for N = 140 and N = 139). This provides further justification for deleting number 100's scores from the analysis.

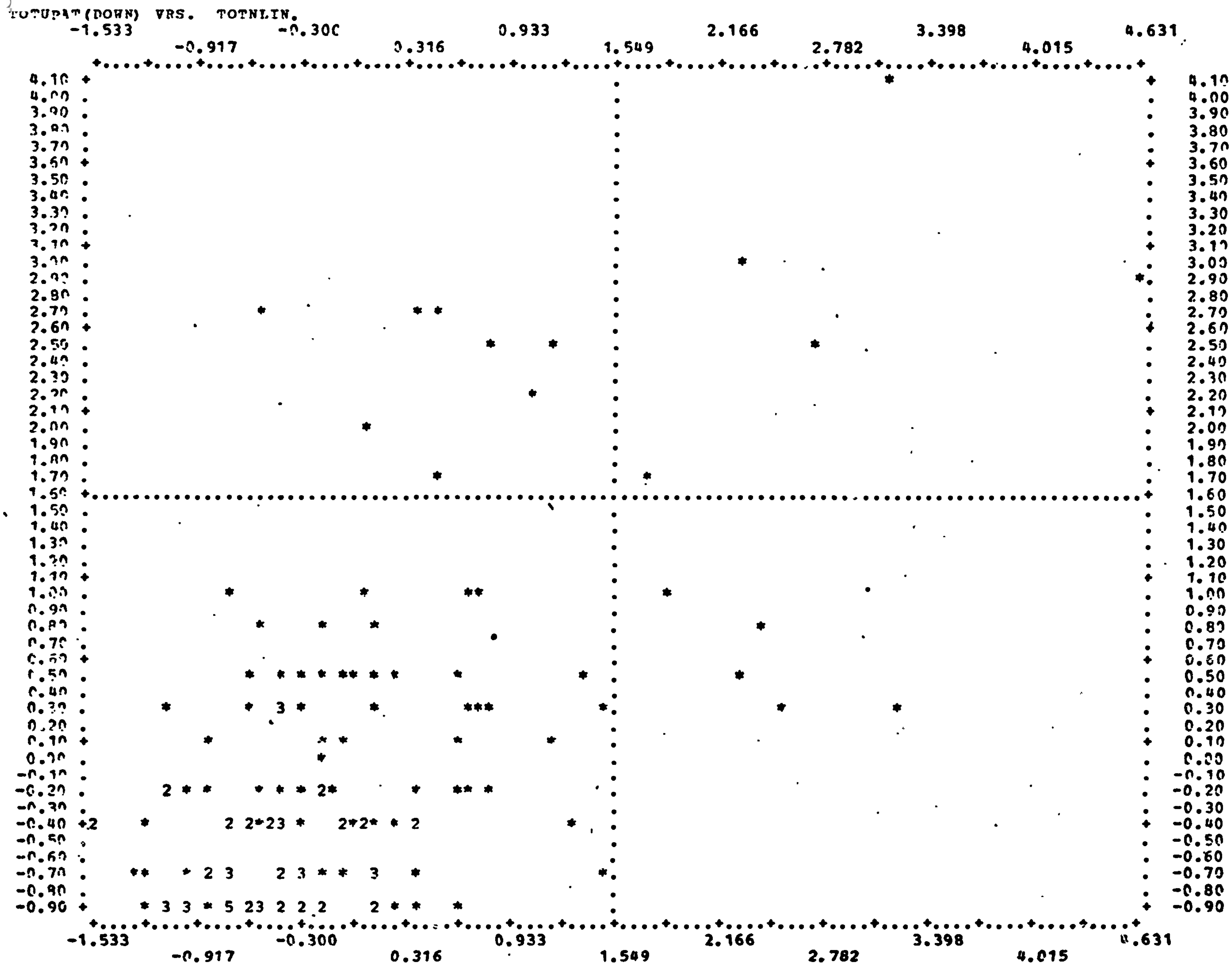

Figure 5.6.6 (N=139)

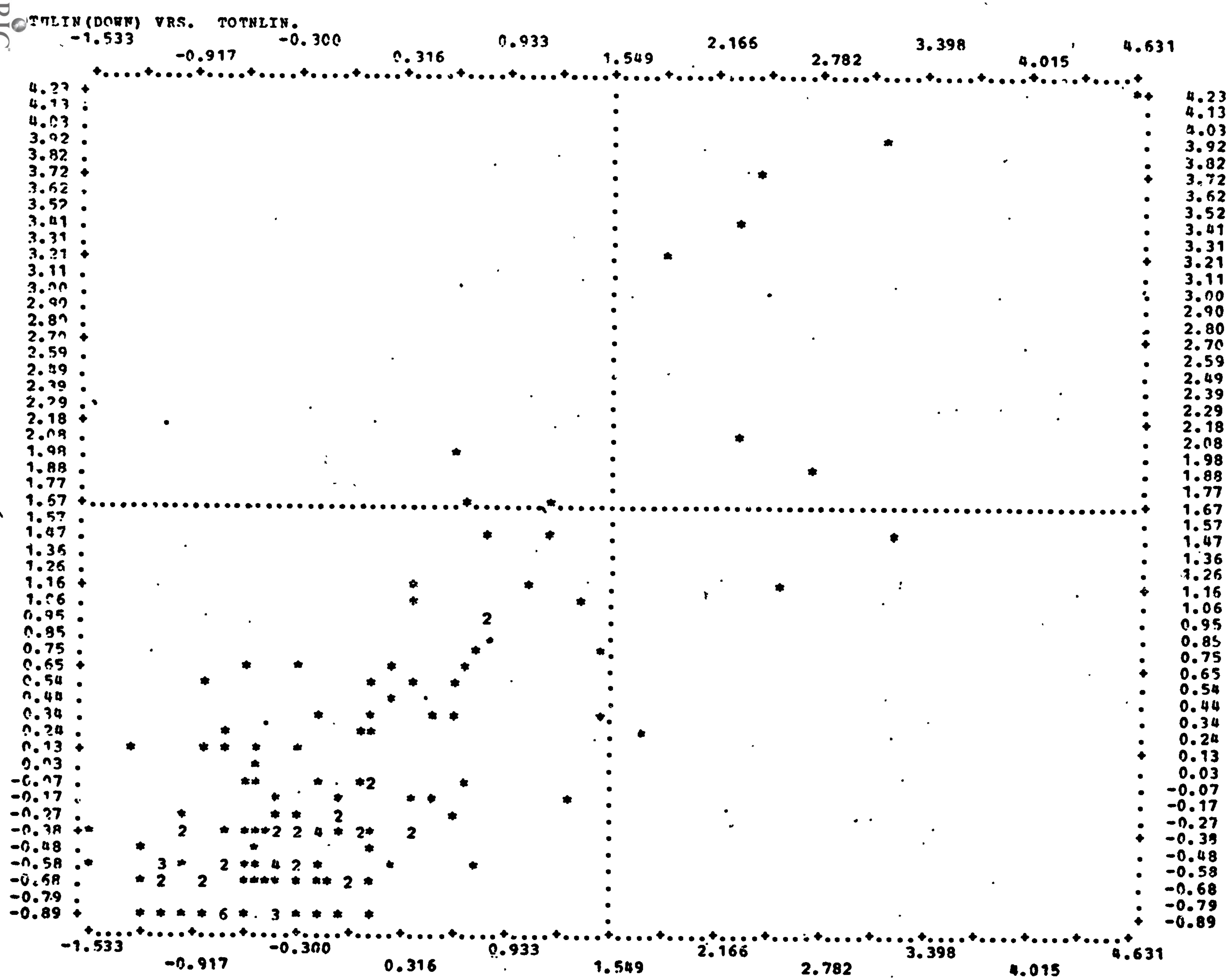

Figure 5.6.7 (N=139)

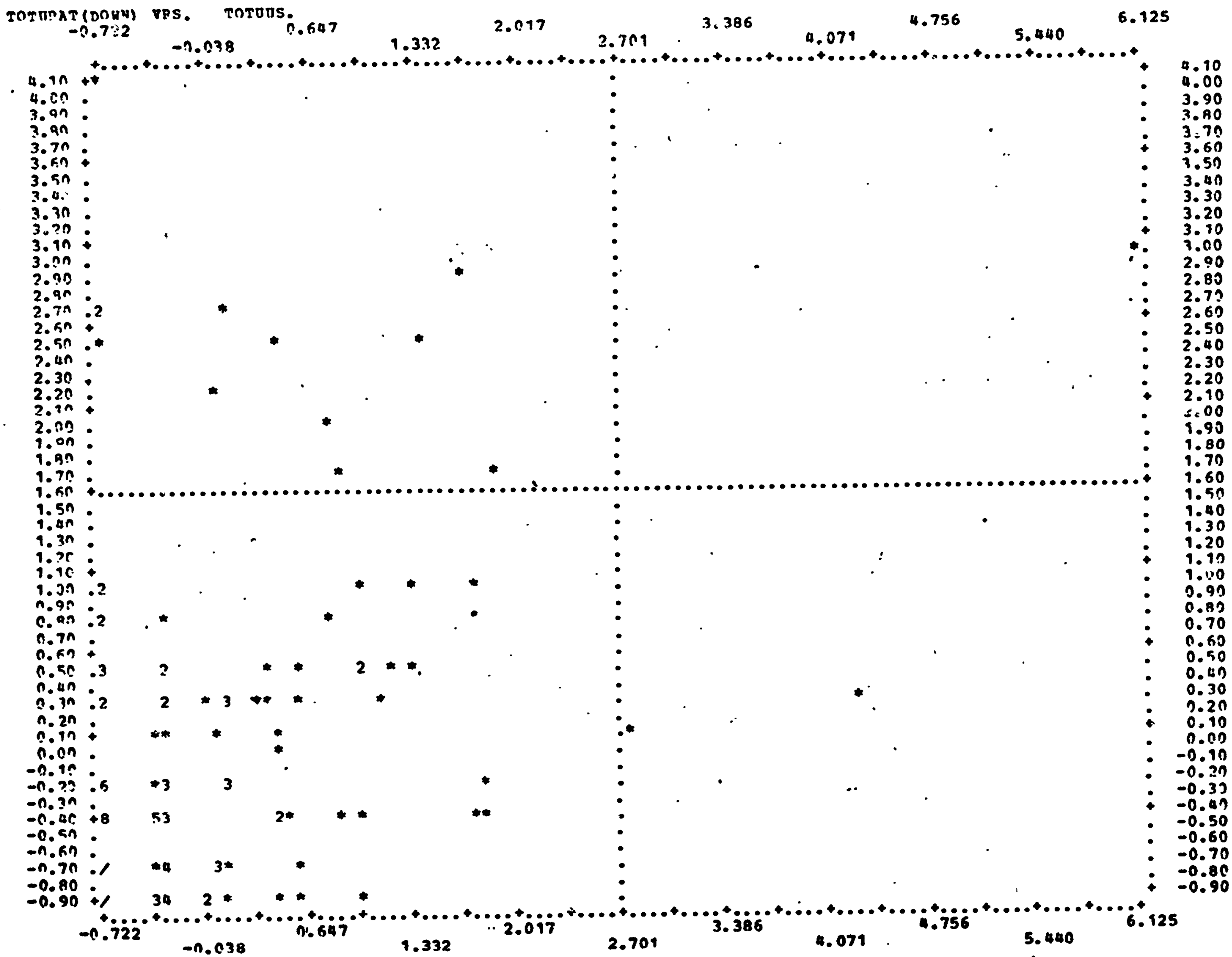

Figure 5.6.8 (N=139)

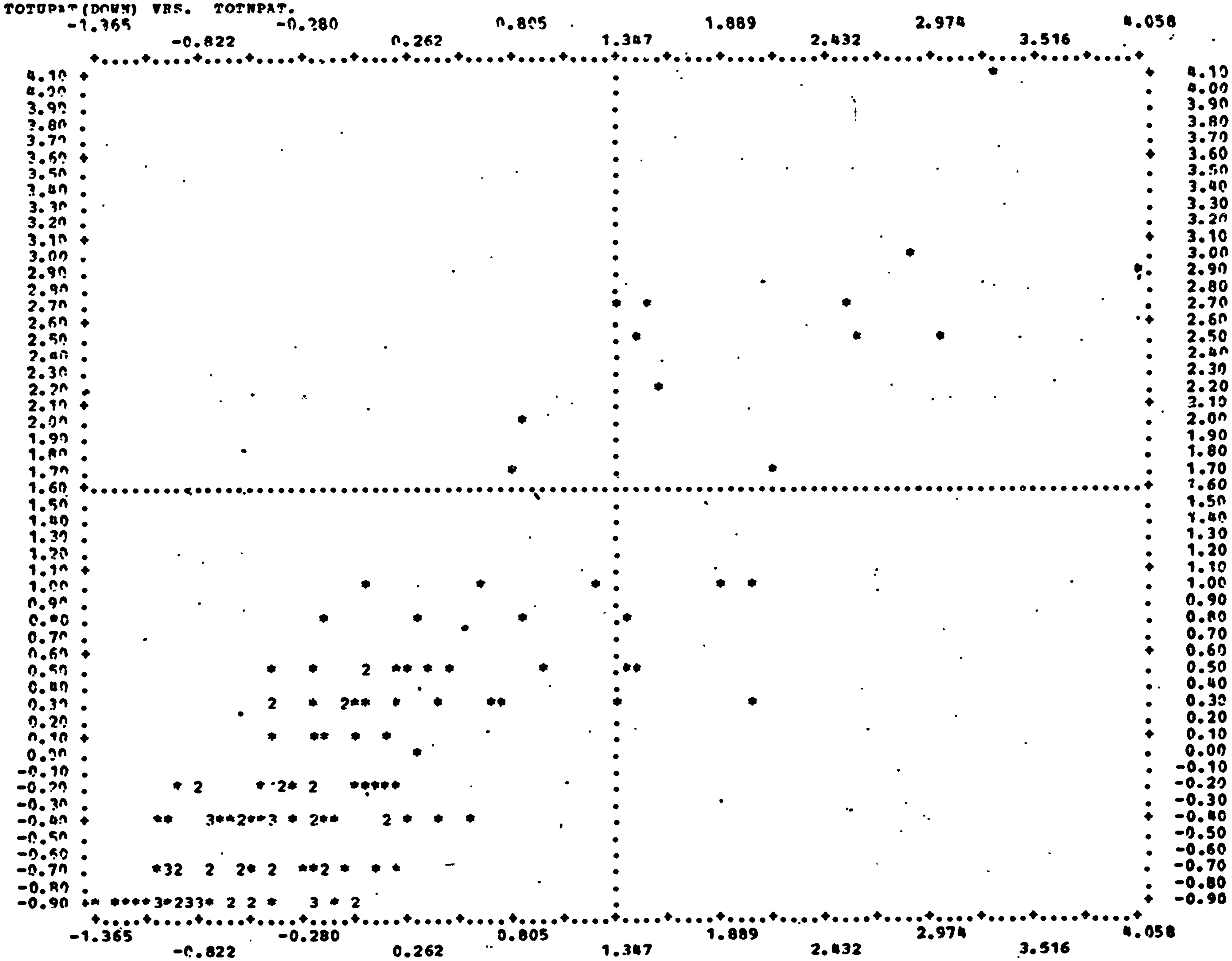

Figure 5.6.9 (N=13

(3) Finally, what in fact is the effect of deleting the scores of student number 100 from these data? A set of means, standard deviations, high and low scores, and the number of the student scoring highest is given in Table 5.6.11 for N = 139. Note that the change in standard deviation is quite significant in the sense explained above. In addition, the distribution of students receiving the highest scores on the various items is more reasonable. A set of the new standard scores for N = 139 is given in Table 5.6.12. No scores are grossly deviant in this instance.

The correlation matrix for N = 139 is given in Table 5.6.13. By comparing Table 5.5.1 with Table 5.6.12, it can be seen that the correlations have decreased markedly. The graph of the correlations given in Figure 5.6.10 shows this clearly. Confidence intervals were also computed for the 276 correlations in each table. For N = 140, every correlation is significantly different from zero at the .01 level. For N = 139, 220 correlations are significant in each table. For N = 140, every correlation is significantly different from zero at the .05 and .01 levels. For N = 139, 220 correlations are significant at the .01 level and 251 at the .05 level. It was decided therefore that the correlations for N = 139 should be used in the remainder of the study. These data should be weaker than the data for N = 140 in the sense of giving positive evidence for the coherence of the creativity dimension. In the case of the factor analysis for the identification of substructure, the data for N = 139 will probably be better. Uniformly high correlations due to one student's scores might mask the underlying structure in the data. However, for comparison, a factor analysis is presented in Appendix 2 for N = 140.

NUSES1(DOWN) VRS. NUSES1. FILE CORREL.

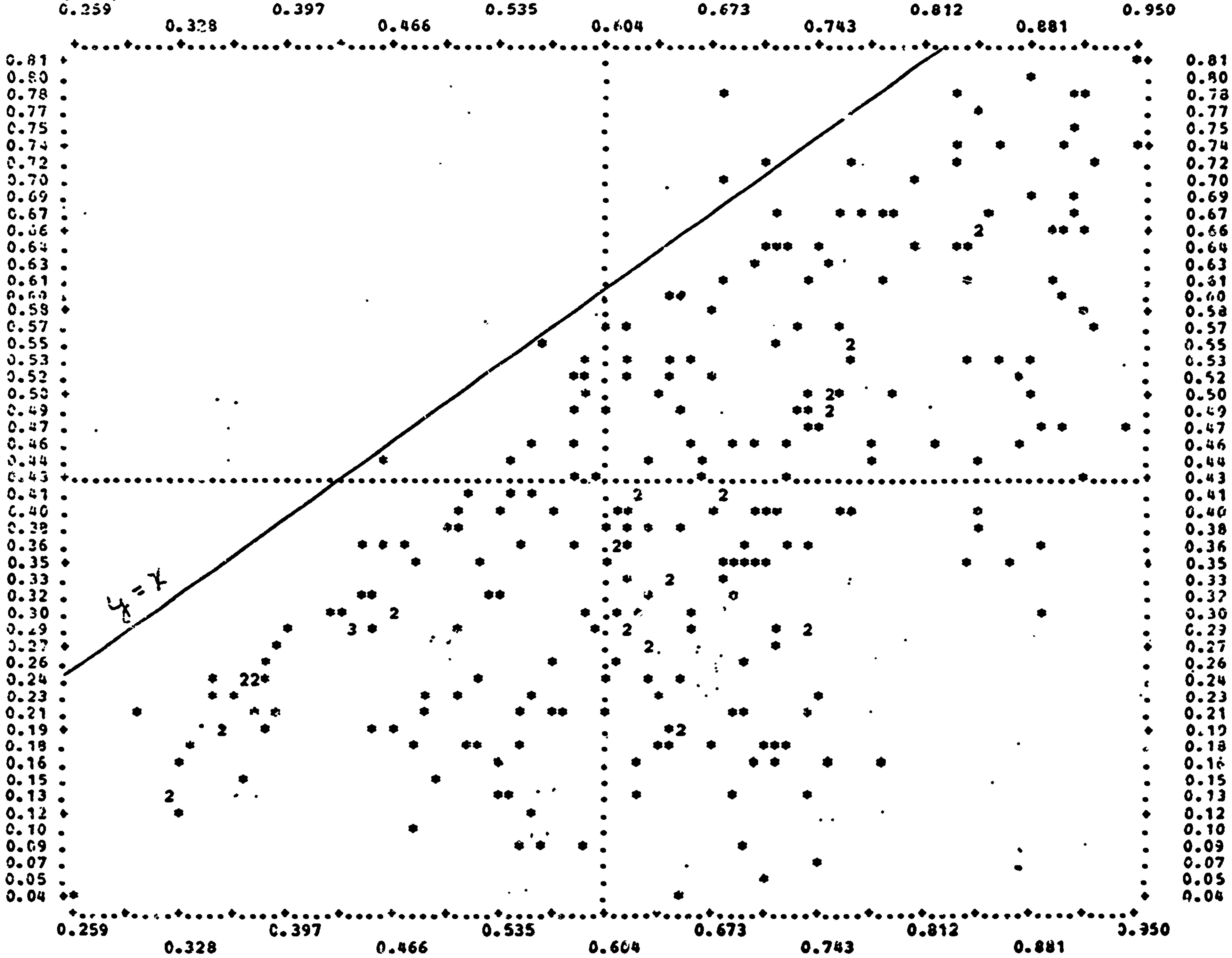

Fig. 5.6.10

--VARIABLE-- NUMBER	LABEL	CARD NUMBER	IN COL	GOOD N	MISS N	LABEL OF FIRST MISSING CASE	BAD N	LABEL OF FIRST BAD CASE	MEAN	STANDARD DEVIATION	LABEL OF FIRST LOW SCORE	LOW SCORE	HIGH SCORE	LABEL OF FIRST HIGH SC.
1	NUSES1	1	11 -13	139	0		0		15.2806	12.5138	L048	3.0000	90.0000	L353
2	NUSES2	1	14 -16	139	0		0		7.8705	4.9326	L048	1.0000	35.0000	L258
3	NUSES3	1	17 -19	139	0		0		7.1223	5.0883	L082	1.0000	25.0000	L254
4	NPAT1	1	20 -22	139	0		0		5.7554	3.8104	L008	1.0000	19.0000	L354
5	NPAT2	1	23 -25	139	0		0		5.5468	3.8301	L345	0.0	23.0000	L352
6	NPAT3	1	26 -28	139	0		0		3.9712	2.9512	L134	0.0	15.0000	L352
7	NSIM1	1	29 -31	139	0		0		7.4964	4.4386	L112	0.0	31.0000	L155
8	NSIM2	1	32 -34	139	0		0		6.6475	4.3553	L003	1.0000	26.0000	L155
9	NSIM3	1	35 -37	139	0		0		5.6763	4.1182	L003	0.0	26.0000	L155
10	NLIN1	1	38 -40	139	0		0		6.1871	3.3309	L295	0.0	19.0000	L032
11	NLIN2	1	41 -43	139	0		0		5.0216	3.3911	L345	0.0	22.0000	L352
12	NLIN3	1	44 -46	139	0		0		5.4317	3.2124	L046	1.0000	17.0000	L352
13	UUSES1	1	47 -49	139	0		0		0.6331	1.4098	L003	0.0	9.0000	L281
14	UUSES2	1	50 -52	139	0		0		0.6115	1.1262	L003	0.0	6.0000	L042
15	UUSES3	1	53 -55	139	0		0		0.5899	1.1409	L003	0.0	6.0000	L254
16	UPAT1	1	56 -58	139	0		0		1.2806	1.6855	L008	0.0	8.0000	L350
17	UPAT2	1	59 -61	139	0		0		1.1439	1.7218	L003	0.0	13.0000	L032
18	UPAT3	1	62 -64	139	0		0		1.3165	1.6726	L003	0.0	9.0000	L128
19	USIM1	1	65 -67	139	0		0		0.5755	1.0900	L001	0.0	9.0000	L155
20	USIM2	1	68 -70	139	0		0		0.5396	1.3793	L003	0.0	12.0000	L155
21	USIM3	2	11 -13	139	0		0		0.5899	1.5408	L003	0.0	16.0000	L155
22	ULIN1	2	14 -16	139	0		0		0.8345	1.3758	L001	0.0	9.0000	L032
23	ULIN2	2	17 -19	139	0		0		1.4029	1.9401	L010	0.0	12.0000	L033
24	ULIN3	2	20 -22	139	0		0		1.1871	1.4967	L010	0.0	8.0000	L055

Table 5.6.11

SITION	LABEL	1 TOTNUS	2 TOTNPAT	3 TOTNSIM	4 TOTNLIN	5 TOTUUS	6 TOTUPAT	7 TOTUSIM	8 TOTULIN
1	L001	-0.42	0.15	2.61	0.61	0.46	0.06	0.54	0.38
2	L003	-0.11	-0.15	-1.26	-0.52	-0.72	-0.42	-0.48	-0.39
3	L008	-0.67	-1.22	-0.06	-0.74	-0.30	-0.90	-0.14	0.22
4	L010	-0.99	-0.09	0.39	0.16	-0.72	-0.90	-0.24	-0.89
5	L012	0.21	-0.68	0.27	0.14	-0.72	-0.90	0.03	-0.46
6	L014	-0.59	-0.55	-0.57	-0.86	-0.72	-0.90	-0.21	-0.89
7	L022	0.73	-0.50	1.19	-0.40	0.54	-0.42	0.03	-0.33
8	L024	-0.33	-0.62	-0.83	-0.75	0.04	-0.65	-0.48	-0.61
9	L025	-0.71	-0.84	-0.75	-0.75	-0.04	-0.90	-0.48	-0.89
10	L026	-0.59	-0.31	-0.40	-0.18	-0.72	-0.17	-0.48	-0.67
11	L027	-0.64	-0.03	-0.41	-0.30	-0.30	0.29	-0.24	0.62
12	L028	-0.02	0.57	0.00	1.29	0.47	-0.43	-0.14	-0.18
13	L029	0.51	-0.84	0.19	0.36	-0.30	-0.18	0.20	1.12
14	L032	0.73	3.31	1.22	3.16	-0.72	4.10	1.22	3.92
15	L033	0.10	1.38	0.87	2.39	-0.30	0.78	-0.00	3.71
16	L035	-0.50	-0.21	0.12	-0.29	-0.72	0.55	-0.48	-0.39
17	L038	-0.17	-0.46	-0.41	-0.85	-0.30	0.06	-0.14	0.10
18	L040	-0.55	0.30	-0.39	-0.19	0.46	0.05	0.54	0.32
19	L042	1.35	-0.24	-0.66	-0.41	1.83	-0.17	-0.48	-0.39
20	L044	-0.85	-0.96	-0.32	-0.74	-0.72	-0.65	0.03	-0.89
21	L046	-0.37	-0.86	-0.17	-1.20	0.47	-0.90	-0.14	-0.46
22	L048	-1.20	-0.93	-1.34	-1.20	-0.72	-0.66	-0.48	-0.67
23	L051	0.07	1.59	0.11	1.06	0.04	2.24	0.10	1.14
24	L052	-0.57	-0.15	-0.40	-0.30	0.04	-0.66	-0.00	-0.61
25	L053	-0.04	0.14	-0.33	0.70	-0.38	-0.18	-0.14	0.67
26	L055	0.40	2.59	1.22	2.74	-0.72	2.46	0.06	1.87
27	L059	1.49	0.16	1.46	-0.41	1.72	-0.43	0.61	-0.89
28	L068	0.39	-0.67	0.18	-0.51	0.96	-0.41	-0.24	-0.67
29	L070	-0.59	-0.53	-0.67	-0.86	-0.72	-0.66	-0.48	-0.67
30	L073	-0.32	-0.78	-0.58	0.61	0.55	-0.90	-0.14	-0.30
31	L074	-0.71	-0.49	-0.75	-0.30	-0.72	-0.19	-0.48	-0.61
32	L075	-0.34	-0.96	-0.16	-0.75	-0.38	-0.90	-0.14	-0.89
33	L076	1.11	1.45	1.18	0.81	0.46	2.45	0.95	1.51
34	L079	0.25	0.68	1.87	1.50	0.38	0.31	1.88	0.77
35	L082	-1.22	-0.43	-0.41	-0.85	-0.72	-0.66	-0.48	0.56
36	L090	0.42	-0.21	-0.59	-0.85	0.12	-0.19	-0.21	-0.67
37	L092	-0.01	0.07	-0.06	-0.18	0.38	0.55	-0.21	-0.39
38	L094	0.33	2.15	1.03	1.73	0.88	1.72	0.95	0.19
39	L096	0.33	0.19	1.38	0.16	0.13	-0.65	0.60	-0.11
40	L097	-0.85	-1.15	-0.33	-0.97	-0.72	-0.90	-0.21	-0.89
41	L098	-0.63	0.00	-0.58	0.27	-0.72	-0.90	-0.00	-0.61
42	L099	-0.54	-0.28	-0.34	-0.75	-0.30	-0.65	-0.48	-0.39
43	L103	0.60	0.19	-0.24	-0.09	0.12	-0.18	-0.14	-0.67
44	L108	1.12	1.45	1.46	2.29	1.30	0.55	0.20	3.38
45	L112	-0.19	-0.43	-0.90	-0.63	0.30	0.30	0.51	0.65
46	L114	-0.71	-1.05	-0.75	-1.53	-0.30	-0.42	-0.14	-0.58
47	L115	-0.75	-0.74	-0.32	-0.31	-0.72	-0.66	-0.14	0.15
48	L118	0.07	-0.74	-0.76	0.05	-0.38	-0.41	-0.48	-0.37
49	L120	-0.84	-0.93	-0.83	-1.08	-0.72	-0.18	-0.14	-0.89
50	L123	0.59	0.07	0.19	-0.07	0.98	0.53	-0.14	-0.30

Table 5.6.12

POSITION		1	2	3	4	5	6	7	8
	LABEL	TOTNUS	TOTNPAT	TOTNSIM	TOTNLIN	TOTUUS	TOTUPAT	TOTUSIM	TOTULIN
51	L128	0.30	1.34	0.18	0.49	-0.72	2.72	0.88	-0.15
52	L134	-0.92	-0.42	-0.74	-0.52	-0.38	-0.90	-0.24	-0.60
53	L136	3.12	-0.05	0.00	0.16	1.14	0.29	0.44	0.33
54	L138	2.76	0.81	1.02	0.49	1.91	1.73	0.44	0.38
55	L139	1.10	-0.62	0.27	-0.64	0.88	-0.41	-0.48	-0.67
56	L142	-0.58	-0.47	0.29	-0.53	-0.38	-0.41	-0.48	0.15
57	L143	-0.82	-0.12	-0.08	-0.06	-0.72	-0.41	-0.48	-0.30
58	L146	0.16	-0.21	0.02	-0.30	0.13	-0.90	-0.24	-0.89
59	L154	-0.37	-0.24	-0.32	-0.18	-0.30	-0.65	-0.48	-0.61
60	L155	2.76	0.41	5.35	0.38	2.40	-0.41	9.70	1.08
61	L158	-0.46	0.10	-0.75	-0.52	0.12	-0.18	-0.24	-0.46
62	L159	-0.24	0.50	-0.32	0.15	-0.30	0.55	-0.48	-0.33
63	L160	-0.47	-0.24	-0.48	-0.41	-0.72	-0.90	-0.48	-0.67
64	L166	-1.11	-1.36	-1.25	-0.74	-0.72	-0.90	-0.48	-0.89
65	L168	-0.34	-0.15	-0.66	-0.29	-0.72	-0.66	0.13	-0.67
66	L171	-0.84	0.38	-0.92	0.03	-0.72	0.54	-0.48	-0.67
67	L173	-0.53	-0.47	-0.74	0.27	0.46	-0.41	-0.48	0.62
68	L177	-0.28	-0.15	-0.91	-0.53	-0.72	0.78	-0.24	-0.67
69	L179	0.65	0.23	-0.58	-0.63	1.22	0.54	-0.14	-0.58
70	L181	-0.51	-0.24	-0.92	-0.75	-0.72	-0.42	-0.48	-0.89
71	L183	-0.68	0.85	0.00	0.14	-0.72	0.79	-0.14	0.19
72	L186	-1.01	-1.05	-1.25	-1.08	-0.30	-0.90	-0.48	-0.61
73	L189	-0.47	-0.15	-0.40	1.16	0.04	0.06	0.13	1.66
74	L190	-0.31	-1.03	-1.17	0.15	0.55	-0.65	-0.48	-0.67
75	L191	0.25	-0.02	0.95	-0.18	-0.30	-0.90	0.13	-0.37
76	L201	-0.24	-0.05	0.34	1.47	-0.30	-0.65	-0.14	0.38
77	L202	-0.84	-0.80	-0.66	-0.42	-0.72	-0.90	-0.48	-0.61
78	L205	-0.70	-0.84	-0.75	-1.09	-0.72	-0.18	-0.48	-0.61
79	L206	0.64	1.89	0.36	0.73	-0.72	1.01	-0.14	-0.61
80	L207	-0.86	-0.77	-0.83	0.15	-0.72	-0.42	-0.48	0.56
81	L215	-0.97	-0.77	-0.91	-0.74	-0.30	-0.42	-0.48	-0.61
82	L216	0.84	-0.43	1.63	-0.07	-0.38	-0.66	0.30	-0.89
83	L217	-0.18	-0.43	-0.23	-0.41	0.12	0.31	-0.48	-0.30
84	L219	-1.12	-0.96	-1.01	-1.53	-0.72	-0.43	-0.21	-0.39
85	L222	-0.58	-0.77	-0.41	-0.40	-0.30	-0.66	-0.14	-0.89
86	L223	-0.10	-0.21	0.85	0.81	0.12	0.30	0.20	0.98
87	L226	-0.62	-0.40	-0.82	-0.97	-0.72	-0.17	-0.00	-0.39
88	L229	1.40	0.31	-0.49	-0.18	0.81	0.78	-0.48	-0.39
89	L231	-0.44	-1.18	-0.83	-0.75	-0.72	-0.90	-0.31	-0.89
90	L232	-0.27	1.50	1.36	-0.52	0.12	2.70	0.40	-0.11
91	L235	1.46	0.66	0.11	0.04	1.31	1.02	0.27	-0.11
92	L237	-0.71	0.10	0.59	0.39	0.04	-0.65	-0.21	-0.33
93	L240	1.60	2.05	3.22	1.84	0.97	1.03	3.20	3.26
94	L241	-0.58	-0.93	-0.24	-1.31	-0.72	-0.66	-0.14	0.13
95	L242	-0.13	-0.46	0.01	-0.41	0.55	0.53	-0.24	-0.58
96	L250	-0.13	-0.86	-0.40	-0.29	-0.72	-0.90	-0.48	-0.30
97	L253	-0.44	-1.03	0.10	-0.64	-0.04	-0.90	-0.48	-0.37
98	L254	2.69	0.73	-0.08	-0.41	4.26	0.31	-0.48	-0.89
99	L255	0.08	0.98	0.10	1.37	0.96	0.54	-0.20	1.04
100	L258	3.11	-0.34	0.70	-0.63	1.83	-0.42	0.20	-0.09

Table 5.6.12 (cont'd)

ITION	LABEL	1 TOTNUS	2 TOTNPAT	3 TOTNSIM	4 TOTNLIN	5 TOTUUS	6 TOTUPAT	7 TOTUSIM	8 TOTULIN
101	L272	0.43	-0.02	0.35	0.61	-0.30	-0.18	-0.48	2.01
102	L281	2.13	0.00	-0.16	-0.18	2.76	0.07	-0.48	-0.11
103	L282	-0.45	0.41	-0.24	0.73	-0.72	0.31	0.03	0.75
104	L288	-1.11	-0.61	-0.83	-0.42	-0.72	-0.66	-0.48	-0.15
105	L289	-0.30	-0.86	-0.50	-0.52	-0.72	-0.90	-0.48	-0.37
106	L291	-0.97	-0.93	-0.41	-1.29	-0.72	-0.90	-0.24	-0.67
107	L292	-0.84	-0.71	-0.91	-0.41	-0.72	-0.41	-0.48	-0.61
108	L293	0.13	-0.20	-0.17	0.38	-0.38	-0.90	-0.14	-0.39
109	L295	1.62	0.07	0.18	-0.75	1.73	1.03	-0.21	0.10
110	L298	0.08	1.41	0.52	0.27	-0.30	0.54	-0.21	0.41
111	L299	-0.49	0.29	-0.75	0.60	-0.72	0.55	-0.48	0.56
112	L300	-0.30	-0.21	0.09	0.05	-0.38	-0.42	0.13	-0.39
113	L301	-0.34	-0.62	-0.68	-1.20	-0.38	-0.41	-0.21	-0.89
114	L303	0.14	0.14	-0.34	-0.07	-0.30	-0.41	0.13	-0.18
115	L304	-1.04	-0.43	-0.56	-0.30	-0.72	-0.42	-0.48	-0.37
116	L306	-0.59	-0.96	-0.49	0.15	-0.72	-0.65	-0.48	-0.11
117	L308	-0.09	0.04	0.09	-0.40	0.12	0.30	-0.48	-0.58
118	L311	0.01	0.26	-0.15	0.38	-0.72	-0.42	0.10	-0.18
119	L314	0.33	2.03	0.89	3.19	-0.30	0.31	0.10	1.45
120	L321	-0.42	-0.55	-0.40	0.04	-0.38	-0.41	-0.48	-0.67
121	L322	-0.53	0.19	0.02	0.70	0.55	0.31	0.44	-0.06
122	L330	-0.06	-0.53	-0.16	-0.63	-0.72	-0.90	-0.14	-0.89
123	L331	-0.30	0.07	-0.24	0.82	-0.72	-0.19	-0.21	0.97
124	L338	-0.73	-1.05	-0.76	-0.97	-0.72	-0.90	-0.48	-0.33
125	L345	-0.67	-1.00	-0.59	-0.96	-0.72	-0.66	-0.48	-0.61
126	L349	-0.56	1.26	0.10	0.71	-0.72	1.02	0.64	1.66
127	L350	3.02	3.03	3.32	1.17	1.39	2.48	2.23	1.51
128	L351	-0.93	-0.84	-1.00	-0.98	-0.30	-0.90	-0.48	-0.30
129	L352	1.32	4.06	2.50	4.63	1.65	2.94	0.37	4.23
130	L353	2.15	-0.93	0.17	-0.17	0.98	-0.90	0.20	-0.89
131	L354	3.87	2.85	2.02	2.29	6.13	2.96	1.83	2.05
132	L356	-1.18	-0.65	-0.67	-0.52	-0.72	-0.90	-0.48	-0.61
133	L357	2.15	1.37	2.77	2.53	-0.04	0.31	1.05	1.14
134	L358	-0.76	-0.05	-0.49	-1.08	-0.72	0.30	-0.24	-0.67
135	L360	-0.20	-0.21	-0.48	-0.08	-0.38	0.07	-0.24	-0.39
136	L363	-0.82	-1.24	-0.84	-1.08	-0.72	-0.90	-0.48	-0.58
137	L364	-0.01	2.53	0.70	0.39	-0.72	2.71	-0.48	0.59
138	L374	-0.64	-0.39	-0.58	-0.19	-0.30	-0.18	-0.48	-0.37
139	L379	0.22	0.85	0.04	0.04	0.80	1.98	0.10	0.19

Table 5.6.12 (cont'd)

POSITION	LABEL	1 NUSES1	2 NUSES2	3 NUSES3	4 NPAT1	5 NPAT2	6 NPAT3	7 NSIM1	8 NSIM2	9 NSIM3	10 NLIN1	11 NLIN2	12 NLIN3	13 UUSES1	14 UUSES2	15 UUSES3	16 UPAT1	17 UPAT2	18 UPAT3
1	NUSES1	100	60	56	31	32	29	52	40	29	21	22	36	71	29	32	28	19	29
2	NUSES2	60	100	72	37	39	39	48	52	41	24	29	36	40	68	45	36	18	34
3	NUSES3	56	72	100	54	52	50	65	61	54	30	38	46	40	41	67	44	35	44
4	NPAT1	31	37	54	100	81	78	47	57	50	64	64	66	19	16	40	73	57	66
5	NPAT2	32	39	52	81	100	75	40	49	53	66	68	66	21	16	34	61	71	67
6	NPAT3	29	39	50	78	75	100	55	65	64	66	67	74	18	18	27	61	53	78
7	NSIM1	52	48	65	47	40	55	100	79	67	41	46	53	31	22	46	35	19	36
8	NSIM2	40	52	61	57	49	65	79	100	79	46	41	56	22	24	44	42	25	40
9	NSIM3	29	41	54	50	53	64	67	79	100	50	52	58	19	19	36	36	31	43
10	NLIN1	21	24	30	64	66	66	41	46	50	100	73	67	9	8	14	40	44	46
11	NLIN2	22	29	38	64	68	67	46	41	52	73	100	71	15	17	22	38	43	56
12	NLIN3	36	36	46	66	66	74	53	56	58	67	71	100	26	14	23	37	35	53
13	UUSES1	71	40	40	19	21	18	31	22	19	9	15	26	100	13	28	21	9	28
14	UUSES2	29	68	41	16	16	18	22	24	19	8	17	14	13	100	27	16	6	18
15	UUSES3	32	45	67	40	34	27	46	44	36	14	22	23	28	27	100	37	17	22
16	UPAT1	28	36	44	73	61	61	35	42	36	40	38	37	21	16	37	100	48	60
17	UPAT2	19	18	35	57	71	53	19	25	31	44	43	35	9	6	17	48	100	46
18	UPAT3	29	34	44	66	67	78	36	40	43	46	56	53	28	18	22	60	46	100
19	USIM1	41	42	48	29	29	37	74	61	53	30	36	37	29	20	34	23	18	22
20	USIM2	24	32	46	33	30	40	63	72	64	18	21	30	17	9	38	28	12	26
21	USIM3	21	23	37	20	24	30	55	54	60	16	22	24	23	5	37	13	12	20
22	ULIN1	15	21	30	47	52	46	35	36	42	65	54	44	4	6	16	31	48	39
23	ULIN2	14	22	28	47	50	45	33	30	39	50	76	49	13	8	22	32	35	42
24	ULIN3	20	26	38	57	53	68	50	51	51	50	61	69	17	13	20	43	36	51

Table 5.6.13

POSITION	LABEL	19 USIM1	20 USIM2	21 USIM3	22 ULIN1	23 ULIN2	24 ULIN3
1	NUSES1	41	24	21	15	14	20
2	NUSES2	42	32	23	21	22	26
3	NUSES3	48	46	37	30	29	38
4	NPAT1	29	33	20	47	47	57
5	NPAT2	29	30	24	52	50	53
6	NPAT3	37	40	30	46	45	68
7	NSIM1	74	63	56	35	33	50
8	NSIM2	61	72	54	36	30	51
9	NSIM3	53	64	60	42	39	51
10	NLIN1	30	18	16	65	59	59
11	NLIN2	36	21	22	54	76	61
12	NLIN3	37	30	24	44	49	69
13	UUSES1	29	17	23	4	13	17
14	UUSES2	20	9	5	6	8	13
15	UUSES3	34	38	37	16	22	20
16	UPAT1	23	28	13	31	22	43
17	UPAT2	18	12	12	40	35	36
18	UPAT3	22	26	20	39	42	51
19	USIM1	100	62	71	39	28	28
20	USIM2	62	100	78	22	19	38
21	USIM3	71	78	100	25	18	26
22	ULIN1	39	22	25	100	51	35
23	ULIN2	28	19	18	51	100	49
24	ULIN3	28	38	26	35	49	100

Table 5.6.13 (cont'd)

5.7 Measures of Ability

In addition to the measures of creativity described above, a number of intelligence measures were also obtained for the students involved in the study. Although a number of the intelligence measures are probably rather closely related, it was decided to simply use all of the information that could reasonably be gathered for the sample. In the Duke Study, Wallach and Wing's aim (The Talented Student, p. 29) was to obtain a single best estimate of each student's general intelligence. In this study, however, using the factor analytic technique, it is better to retain the measures in their pure state and let the analysis identify the structure. A rather good supply of intelligence information was available at the school. The National Educational Development Tests (NEDT) and the National Merit Scholarship Qualifying Test (NMSQT) have been distinguished from other measures as standardized measures of achievement. If this is not reasonable, the factor analysis will indicate it.

Since these measures were obtained from the school, there are a moderate number of missing scores. Some students were absent on days that particular tests were administered; some students withdrew from the school during the course of this study. In every case, the attempt was made to use as much of the available information as possible. The means, standard deviations, high and low scores, and the actual number of scores available for each variable are given in Table 5.7.1. In the analysis, the scores of student number 100 were deleted. The name of each variable is identified below by giving the name of the test score used, the date on which the test was administered, and the acronym used in the computer programs to identify the variable.

INTELLIGENCE MEASURE	N	MEAN	ST. DEV.	LOW SCORE	HIGH SCORE
PSATV	130	47.5385	10.7697	22.0000	71.0000
PSATM	130	50.8846	11.1060	29.0000	75.0000
SATV1	134	505.3357	112.0039	253.0000	727.0000
SATM1	134	528.4028	120.0749	289.0000	766.0000
SATV2	101	511.5247	108.1296	310.0000	760.0000
SATM2	101	562.3069	115.7856	300.0000	800.0000
CTMM	127	121.6457	11.3986	91.0000	148.0000
HENMIQ	133	119.3985	10.5701	86.0000	142.0000

Table 5.7.1: Intelligence Measures

1) May 1967: HENMIQ - Henmon-Nelson IQ Test
2) Oct. 1969: PSATV - Preliminary Scholastic Aptitude Test (Verbal)
3) Oct. 1969: PSATM - Preliminary Scholastic Aptitude Test (Math)
4) May 1970: CTMM - California Test of Mental Maturity
5) May 1970: SATV1 - Scholastic Aptitude Test (Verbal)
6) May 1970: SATM1 - Scholastic Aptitude Test (Math)
7) Nov. 1970: SATV2 - Scholastic Aptitude Test (Verbal)
8) Nov. 1970: SATM2 - Scholastic Aptitude Test (Math)

These tests are commonly used intelligence and aptitude tests, and descriptions of them can be found in many standard texts on testing.

5.8 Standardized Measures of Achievement

In addition to the measures described in section 5.7, measures on the NEDT and the NMSQT were available for most of the students in the study. The name of each variable is identified below by giving the name of the test score used, the date on which the test was administered, and the acronym used in the computer programs to identify the variables.

1) Mar. 1968: ENG1 - NEDT (English Usage)
2) Mar. 1968: MATH1 - NEDT (Mathematics Usage)
3) Mar. 1968: SOCST1 - NEDT (Social Studies Reading)
4) Mar. 1968: NATSC1 - NEDT (Natural Science Reading)
5) Mar. 1968: WORDU1 - NEDT (Word Usage)
6) Feb. 1969: ENG2 - NEDT (English Usage)
7) Feb. 1969: MATH2 - NEDT (Mathematics Usage)
8) Feb. 1969: SOCST2 - NEDT (Social Studies Reading)

STANDARD ACHIEVEMENT TEST	N	MEAN	ST. DEV.	LOW SCORE	HIGH SCORE
ENG1	134	17.4701	4.1706	9.0000	28.0000
MATH1	134	20.1492	6.1954	4.0000	33.0000
SOCST1	134	19.5149	5.0794	6.0000	32.0000
NATSC1	134	19.6940	5.9537	3.0000	32.0000
WORDU1	134	22.7388	5.1180	11.0000	33.0000
ENG2	136	17.6544	4.0321	7.0000	26.0000
MATH2	136	22.4044	6.2933	9.0000	34.0000
SOCST2	136	21.0662	5.0365	7.0000	30.0000
NATSC2	136	20.9044	5.8511	6.0000	34.0000
WORDU2	136	23.9265	4.5794	14.0000	34.0000
ENG3	134	19.5597	6.0741	7.0000	32.0000
MATH3	133	22.3459	4.8227	10.0000	33.0000
SSTNSC3	134	20.4552	5.8046	7.0000	31.0000
WORDU3	134	22.9478	4.9224	14.0000	32.0000

Table 5.8.1: Standard Achievement Measures

9) Feb. 1969: NATSC2 - NEDT (Natural Science Reading)

10) Feb. 1969: WORDU2 - NEDT (Word Usage)

11) Mar. 1970: ENG3 - NMSQT (English Usage)

12) Mar. 1970: MATH3 - NMSQT (Mathematics Usage)

13) Mar. 1970: SSTNSC3 - NMSQT (Social Studies and Natural Science Reading)

14) Mar. 1970: WORDU3 - NMSQT (Word Usage)

Descriptive material on these tests can be found in standardized texts on testing. Means, standard deviations, high and low scores, and the number of actual scores available for each variable are given in Table 5.8.1.

5.9 School Measures of Achievement

In addition to the measures of creativity, intelligence, and standard achievement, an attempt was made to obtain student grades. After examining the curriculum and student schedules, it was decided that useful information could be provided by comparing student grades in English, mathematics, science, and social studies. These grades were available for substantial numbers of students. In addition, the student's overall average for grades 9, 10, and 11 was available and used. This average is a three year cumulative average computed by the school for all academic subjects taken by the student. While this measure is in large part determined by the subjects listed above, it is not necessarily totally determined by them. The extent of determination should come out in the analysis of the data. The name of each variable is identified below by giving the name of the course, the grade when appropriate, and the acronym used in the computer programs.

SUBJECT	N	MEAN	ST. DEV.	LOW SCORE	HIGH SCORE
ENGGR9	139	87.4532	7.0106	68.0000	99.0000
ENGGR10	139	86.2734	6.2732	62.0000	99.0000
ENGGR11	135	86.8889	7.9810	65.0000	99.0000
MATHGR9	139	83.8633	10.4564	57.0000	99.0000
MATHGR10	139	81.2446	11.0898	56.0000	99.0000
MATHGR11	135	79.8889	11.2221	53.0000	98.0000
BIOL9	139	82.9640	8.3955	65.0000	97.0000
SCGR10	138	82.7391	9.6579	65.0000	99.0000
WORGEOG	138	86.2536	6.4887	71.0000	98.0000
WORHIST	137	81.4234	10.2969	56.0000	98.0000
USHIST	132	81.6136	7.7407	60.0000	97.0000
AVER	132	84.1591	6.6583	70.0000	97.0000

Table 5.9.1: Measures of School Achievement

1) GRADE 9: ENGGR9 - English Grade 9

2) GRADE 10: ENGGR10 - English Grade 10

3) GRADE 11: ENGGR11 - English Grade 11

4) GRADE 9: MATHGR9 - Mathematics Grade 9

5) GRADE 10: MATHGR10 - Mathematics Grade 10

6) GRADE 11: MATHGR11 - Mathematics Grade 11

7) GRADE 9: BIOL9 - Biology (usually Grade 9)

8) GRADE 10: SCGR10 - Chemistry, Physics, or Earth Science

9) WORGEOG - World Geography (various grades)

10) WORHIST - World History (various grades)

11) USHIST - United States History (various grades)

12) AVER - Cumulative three year average

The means, standard deviations, high and low scores, and the number of actual scores available for each variable are given in Table 5.9.1.

This summarizes the measures that were actually obtained for the students in the study.

5.10 Hypotheses

Although the various hypotheses to be tested in this study have been indicated in several previous sections, they will be restated here for reference.

I. There exists an identifiable and measurable dimension of human behavior fairly called creativity. This hypothesis can be verified by demonstrating that a set of measures can be obtained which have high interitem correlations and item-test correlations. The measures should be reliable. This would be good verification that "something" has been measured. To demonstrate that

the "something" is creativity is more difficult. In this study, the justification is not statistical but theoretical (Chapter 2). It is, of course, assumed that writing down many ideas corresponds to having many ideas, and it is this behavior that is the criterion for the measures. High scores indicate fluency and uniqueness in generating "ideas" related to uses of things, similarities between things, and meanings of patterns and line drawings.

II. The dimension of creativity is independent of the common dimension of intelligence. This hypothesis should be verified by first verifying the existence of the intelligence dimension by suitable measures. Then, if the two dimensions are independent, they should be relatively uncorrelated. In this study, in addition to examining the average correlations, the correlations will be factor analyzed. If creativity and intelligence form independent dimensions, the factor analysis will yield relatively independent factors underlying the data.

III. The dimension of creativity has a meaningful substructure. This hypothesis will be verified by showing that the creativity data yield a two-fold factor structure that can be related to the verbal and visual stimuli in the materials. The extent of relationship can be determined by an oblique transformation of the underlying factors. In addition, examination of the factor structure of the creativity and intelligence data may provide serendipitous conclusions, for example relationships between the two creativity factors and the mathematics and verbal factors of intelligence. An arbitrary hypothesis that the creativity factors are less independent of the verbal intelligence factor than the mathematical factor can be verified by examining the factor structure in some detail.

IV. The dimensions of creativity and school achievement are not independent. This hypothesis can be verified by checking the significance of the correlations between creativity and school achievement with intelligence held constant. Without a single measure of achievement, it may fairly be expected that the factor study will provide evidence for differential relationships of creativity to school grades. At any rate, examination of the factor structure for all the variables in the study may provide sufficient evidence for a conclusion to be drawn about the relationship between creativity and achievement. One of the disputed conclusions of Getzels and Jackson was that creativity does influence grades apart from intelligence.

To summarize, then, the creativity measures will be examined alone, then together with ability only, then together with achievement only, and finally, with intelligence and achievement together.

CHAPTER 6

XAVERIAN HIGH SCHOOL SAMPLE: REDUCTION AND ANALYSIS OF THE DATA

6.1 Introduction

In this chapter, the data will be examined for evidence to confirm or deny the hypotheses of Chapter 5. There is no single way to present evidence that will be acceptable to every reader. In this case, the data will be analyzed using the UMLFA program as it was used in examining the data presented in Chapter 4.

6.2 The Creativity Measures

According to the theory of Wallach and Kogan, the creativity measures should cohere. In order to show that they do, the interitem correlations are presented in Table 5.6.13. It can be seen that the evidence for the internal consistency of each task is good, i.e., a person generating many ideas on one item of a given task also tends to generate many ideas on the other items of the task. Correlations from Table 5.6.13 are regrouped below to make this point clear.

CORRELATIONS AMONG PRODUCTIVITY SCORES ON EACH OF THE FOUR TASKS

Item Pairs	Uses	Pattern Meanings	Similarities	Line Meanings
1 vs. 2	.596	.813	.795	.732
1 vs. 3	.563	.777	.674	.674
2 vs. 3	.718	.748	.788	.710

Similarly, the correlations in Table 5.6.13 present fair evidence for the consistency of the uniqueness tasks, i.e., the person who generates many

unique ideas on one item of a given task also tends to do so on the other items of that task. The correlations among the uniqueness scores for the four tasks are regrouped below for clarity. With the exception of the uniqueness scores

CORRELATIONS AMONG UNIQUENESS SCORES ON EACH OF THE FOUR TASKS

Item Pairs	Uses	Pattern Meanings	Similarities	Line Meanings
1 vs. 2	.133	.475	.621	.506
1 vs. 3	.280	.603	.707	.349
2 vs. 3	.270	.457	.777	.493

for Uses, the item-item correlations are sufficiently high to justify adding the scores of the items to obtain the best measure for each subtest. Accordingly, the standard scores for each item were added to provide eight test scores. Since there were only three items to a test, the correlations of the items with the test sum will necessarily be high. In addition, the reliability for a single test cannot reasonably be calculated with only three items in a subtest. However, using all 24 measures of creativity together, a split-half reliability seems to be a meaningful statistic to report. Using every other measure and the Spearman-Brown correction formula, the reliability of the 24 measures considered as a single test is .91. Thus, the measures do appear to cohere and to identify a distinct domain.

6.3 Comparisons of the Data Obtained in Two Studies Using Testing by Mail

One of the misgivings involved in using the testing by mail technique is the lack of control that one has over the subjects. One student may spend several hours on the tests while another may spend only several minutes.

The implicit assumption seems to be that a student will work at some pace determined by himself. He will stop on an item when his fund of ideas is more or less depleted. Naturally there is a trade-off between the amount of time a student will spend and the number of ideas he will generate. Probably he could go on generating for days, but the output would be so slow that the effort would be painful. At the other extreme, a student may try to speed through the entire set of materials in fifteen minutes. Since he need not take the test at all, it would seem that the volunteer would give enough time to do a reasonable job and yet not so much time as to be terribly inconvenienced. This, it seems to me, is a possible explanation for the rather surprising agreement found between the means and standard deviations in the Wallach and Wing Study and the Xaverian High School Study. Although the researcher cannot control the testing conditions, there is a rather natural control built in. In addition, one is tempted to hypothesize that a cognitive ability to generate ideas on these simple tasks not only exists in the population, but that it exists with a somewhat stable mean and variance. This is a serendipitous result which of course may simply be an accident. At any rate, the means and standard deviations for the two groups are given in Table 6.3.1 for consideration.

6.4 Meaningful Substructure

In spite of the seeming triviality of these Wallach and Kogan tasks, they seem not only to define a meaningful dimension, but this dimension appears to possess a meaningful substructure similar to the verbal and mathematical substructure of intelligence measures. This substructure can be most clearly

Table 6.3.1

Productivity Measures

	Wallach and Wing Study		Xaverian High School Study	
	Means	Standard Deviation	Means	Standard Deviation
Uses	28.07	16.81	30.27	19.70
Pattern Meanings	15.63	10.98	15.27	9.80
Similarities	19.35	11.15	19.82	11.80
Line Meanings	16.29	9.65	16.64	8.91

Uniqueness Measures

	Wallach and Wing Study		Xaverian High School Study	
	Means	Standard Deviation	Means	Standard Deviation
Uses	2.21	4.09	1.84	2.56
Pattern Meanings	5.19	5.84	3.74	4.17
Similarities	1.02	1.94	1.71	3.61
Line Meanings	2.96	3.99	3.42	3.86

demonstrated by performing the unrestricted maximum likelihood factor analysis as was done in the studies reanalyzed in Chapter 4. Two, three, and four factor solutions will be presented. The two factor solution clearly shows the underlying figural and verbal dimensions. The three and four factor solutions show that the measures break down according to single tests and do not seem to possess a uniqueness factor independent of the productivity factor. Since the uniqueness scores are very time consuming to obtain, this could be a rather important conclusion. The two factor structure is given in Table 6.4.1. As was pointed out in Chapter 4, this is the best two factor solution in the sense that of all two factor solutions this solution has the highest probability of reproducing the correlation matrix under the assumption of two normally distributed latent traits. The result is quite clear. The figural items and the verbal items have differential loadings on the two factors. Of course, since this is an orthogonal solution, the relatively high loadings of the verbal items on the figural factor and of the figural items on the verbal factor indicate that the two factors are correlated. Using a promax transformation, the correlation between the two factors can be shown to be .334. The three factor solution in Table 6.4.2 shows that the figural factor breaks down first into the line meanings and the pattern meanings. The four factor solution in Table 6.4.3 shows that the two factors will break down along meaning lines, i.e., the four subtests, and there does not appear to be a distinct uniqueness factor. This corroborates the point made in the reanalyses of Chapter 4.

In order to obtain total scores on the various subtests, all the measures were transformed to standard scores. That is to say, for each of the 139

UNIQUE VARIANCES

0.749	0.661	0.473	0.231	0.220	0.202	0.231	0.213	0.329	0.422
0.373	0.372	0.880	0.922	0.724	0.554	0.569	0.427	0.387	0.348
0.446	0.657	0.640	0.506						

VARIMAX-ROTATED FACTOR MATRIX

1	NUSES1	0.212	0.454
2	NUSES2	0.279	0.511
3	NUSES3	0.388	0.613
4	NPAT1	0.830	0.281
5	NPAT2	0.851	0.236
6	NPAT3	0.806	0.384
7	NSIM1	0.292	0.827
8	NSIM2	0.374	0.804
9	NSIM3	0.428	0.699
10	NLIN1	0.732	0.205
11	NLIN2	0.756	0.235
12	NLIN3	0.707	0.358
13	UUSES1	0.133	0.320
14	UUSES2	0.126	0.249
15	UUSES3	0.201	0.485
16	UPAT1	0.631	0.219
17	UPAT2	0.655	0.049
18	UPAT3	0.729	0.202
19	USIM1	0.126	0.773
20	USIM2	0.094	0.802
21	USIM3	0.021	0.744
22	ULIN1	0.539	0.229
23	ULIN2	0.574	0.175
24	ULIN3	0.614	0.343

Table 6.4.1: Creativity Data, (UMLFA 2 Factor Solution)

UNIQUE VARIANCES

1	0.515	0.253	0.245	0.234	0.227	0.198	0.259	0.223	0.296	0.385
	0.351	0.364	0.738	0.621	0.616	0.537	0.580	0.428	0.387	0.267
	0.334	0.631	0.622	0.482						

VARIMAX-ROTATED FACTOR MATRIX

1	NUSES1	0.153	0.191	0.652
2	NUSES2	0.196	0.199	0.818
3	NUSES3	0.333	0.348	0.723
4	NPAT1	0.819	0.152	0.270
5	NPAT2	0.833	0.123	0.251
6	NPAT3	0.822	0.294	0.199
7	NSIM1	0.327	0.697	0.385
8	NSIM2	0.410	0.701	0.342
9	NSIM3	0.475	0.662	0.200
10	NLIN1	0.766	0.166	0.031
11	NLIN2	0.780	0.178	0.093
12	NLIN3	0.728	0.267	0.186
13	UUSES1	0.082	0.130	0.488
14	UUSES2	0.048	0.002	0.614
15	UUSES3	0.162	0.307	0.513
16	UPAT1	0.600	0.079	0.310
17	UPAT2	0.636	−0.014	0.123
18	UPAT3	0.711	0.091	0.240
19	USIM1	0.165	0.712	0.281
20	USIM2	0.144	0.828	0.162
21	USIM3	0.076	0.808	0.084
22	ULIN1	0.567	0.214	0.032
23	ULIN2	0.595	0.146	0.047
24	ULIN3	0.647	0.304	0.087

Table 6.4.2.: Creativity Data, (UMLFA3 Factor Solution)

UNIQUE VARIANCES

0.524	0.194	0.265	0.168	0.213	0.201	0.254	0.214	0.304	0.358
0.088	0.350	0.753	0.555	0.630	0.395	0.557	0.413	0.353	0.222
0.328	0.614	0.416	0.482						

VARIMAX-ROTATED FACTOR MATRIX

1	NUSES1	0.086	0.198	0.640	0.142
2	NUSES2	0.115	0.193	0.852	0.173
3	NUSES3	0.144	0.366	0.680	0.343
4	NPAT1	0.374	0.183	0.202	0.786
5	NPAT2	0.450	0.148	0.204	0.722
6	NPAT3	0.443	0.316	0.169	0.689
7	NSIM1	0.294	0.691	0.385	0.182
8	NSIM2	0.201	0.716	0.325	0.357
9	NSIM3	0.354	0.658	0.205	0.309
10	NLIN1	0.650	0.150	0.058	0.441
11	NLIN2	0.880	0.130	0.135	0.320
12	NLIN3	0.590	0.259	0.202	0.440
13	UUSES1	0.051	0.138	0.467	0.081
14	UUSES2	0.072	-0.017	0.663	0.017
15	UUSES3	0.026	0.323	0.458	0.234
16	UPAT1	0.112	0.123	0.228	0.725
17	UPAT2	0.272	0.018	0.067	0.603
18	UPAT3	0.347	0.118	0.194	0.644
19	USIM1	0.260	0.697	0.306	-0.004
20	USIM2	0.017	0.855	0.127	0.173
21	USIM3	0.101	0.810	0.077	0.012
22	ULIN1	0.502	0.202	0.058	0.300
23	ULIN2	0.726	0.105	0.089	0.195
24	ULIN3	0.484	0.304	0.086	0.429

Table 6.4.3: Creativity Data, (UMLFA 4 Factor Solution)

CONFIDENCE (99%) INTERVALS FOR MURPHY'S CORRELATION MATRIX

ROW	COL	ROW VAR	COL VAR	R	T	DF	P(T)	99% CONFIDENCE INTERVAL	
2	1	TOTNPAT	TOTNUS	0.50316	6.81	137	0.00000	0.32135	0.64919
3	1	TOTNSIM	TOTNUS	0.62017	9.25	137	0.00000	0.46597	0.73781
3	2	TOTNSIM	TOTNPAT	0.63146	9.53	137	0.00000	0.48037	0.74615
4	1	TOTNLIN	TOTNUS	0.40472	5.18	137	0.00000	0.20592	0.57144
4	2	TOTNLIN	TOTNPAT	0.80436	15.85	137	0.00000	0.71162	0.86955
4	3	TOTNLIN	TOTNSIM	0.60227	8.83	137	0.00000	0.44330	0.72451
5	1	TOTUUS	TOTNUS	0.79750	15.47	137	0.00000	0.70205	0.86480
5	2	TOTUUS	TOTNPAT	0.36198	4.55	137	0.00002	0.15747	0.53672
5	3	TOTUUS	TOTNSIM	0.45750	6.02	137	0.00000	0.26713	0.61350
5	4	TOTUUS	TOTNLIN	0.26217	3.18	137	0.00183	0.04832	0.45327
6	1	TOTUPAT	TOTNUS	0.44639	5.84	137	0.00000	0.25411	0.60472
6	2	TOTUPAT	TOTNPAT	0.85995	19.72	137	0.00000	0.79959	0.90756
6	3	TOTUPAT	TOTNSIM	0.45331	5.95	137	0.00000	0.26221	0.61020
6	4	TOTUPAT	TOTNLIN	0.59353	8.63	137	0.00000	0.43233	0.71799
6	5	TOTUPAT	TOTUUS	0.34001	4.23	137	0.00005	0.13294	0.51864
7	1	TOTUSIM	TOTNUS	0.45082	5.91	137	0.00000	0.25939	0.60923
7	2	TOTUSIM	TOTNPAT	0.36593	4.60	137	0.00001	0.16100	0.53905
7	3	TOTUSIM	TOTNSIM	0.75787	13.60	137	0.00000	0.64740	0.83715
7	4	TOTUSIM	TOTNLIN	0.32485	4.01	137	0.00010	0.11572	0.50570
7	5	TOTUSIM	TOTUUS	0.37878	4.79	137	0.00001	0.17639	0.55004
7	6	TOTUSIM	TOTUPAT	0.26209	3.19	137	0.00183	0.04794	0.45321
8	1	TOTULIN	TOTNUS	0.34558	4.31	137	0.00004	0.13913	0.52324
8	2	TOTULIN	TOTNPAT	0.70355	11.59	137	0.00000	0.57430	0.79258
8	3	TOTULIN	TOTNSIM	0.56171	7.95	137	0.00000	0.39267	0.69404
8	4	TOTULIN	TOTNLIN	0.82528	15.90	137	0.00000	0.73291	0.87319
8	5	TOTULIN	TOTUUS	0.23028	2.83	137	0.00456	0.02363	0.43365
8	6	TOTULIN	TOTUPAT	0.60601	8.92	137	0.00000	0.44892	0.72730
8	7	TOTULIN	TOTUSIM	0.37823	4.73	137	0.00001	0.17577	0.54999

Table 6.4.4: Confidence (99%) Intervals for the Creativity Correlations

scores for a particular item, that score was subtracted from the mean, and the difference was divided by the standard deviation of the scores. The result is a score distribution with a mean of 0 and a standard deviation of 1. Then the three standard scores for each task were added to obtain a score for that task. Thus, the final result is a set of eight creativity scores: four productivity scores, and four uniqueness scores. The correlations among these, together with 99% confidence intervals, are given in Table 6.4.4.

6.5 Independence of the Creativity and Intelligence Dimensions

Using the eight creativity measures and the eight ability measures described in Chapter 5, an unrestricted maximum likelihood factor analysis was performed on the correlations of these 16 measures. The correlation matrix is given in Table 6.5.1. The results for 2, 3, and 4 factors are given in Table 6.5.2, 6.5.3, and 6.5.4. The two factor solution gives rather clear evidence for the independence of the creativity and intelligence dimensions as defined by these tests and in this particular sample. The three factor solution shows two intelligence and one creativity factor, the intelligence factor having broken down into a verbal and a mathematical factor. The four factor result gives the clear four factor structure that one would expect from these measures. The first and fourth factors are verbal and mathematical ability factors, the second factor is a figural "creativity" factor, and the third factor is a verbal "creativity" factor. The correlations between the "creativity" factors and between the verbal and mathematical ability factors are .473 and .115 respectively.

	1 TOTNUS	2 TOTNPAT	3 TOTNSIM	4 TOTNLIN	5 TOTUUS	6 TOTUPAT	7 TOTUSIM	8 TOTULIN	9 PSATV	10 PSATM	11 SATV1	12 SATM1	13 SATV2	14 SATM2	15 CTMM	16 HENMIQ
TOTNUS	100	50	62	40	80	45	45	35	8	16	8	15	11	10	17	7
TOTNPAT	50	100	63	80	36	86	37	70	-4	11	-4	17	1	5	13	-10
TOTNSIM	62	63	100	60	46	45	76	56	6	21	11	25	8	11	26	5
TOTNLIN	40	60	60	100	26	59	32	81	-6	5	-4	14	1	3	12	-10
TOTUUS	80	36	46	26	100	34	38	24	7	10	4	6	5	1	8	3
TOTUPAT	45	86	45	59	34	100	26	61	5	12	4	16	4	2	13	-8
TOTUSIM	45	37	76	32	38	26	100	38	7	21	12	27	8	18	19	8
TOTULIN	35	70	56	81	24	61	38	100	1	7	0	18	7	7	15	-7
PSATV	8	-4	6	-6	7	5	7	1	100	72	89	76	92	67	70	71
PSATM	16	11	21	5	10	12	21	7	72	100	67	88	70	87	63	60
SATV1	8	-4	11	-4	4	4	12	0	89	67	100	71	91	70	79	72
SATM1	15	17	25	14	6	16	27	18	76	88	71	100	73	91	67	58
SATV2	11	1	8	1	5	4	8	7	92	70	91	73	100	72	76	69
SATM2	10	5	11	3	1	2	18	7	67	87	70	91	72	100	64	54
CTMM	17	13	26	12	8	13	19	15	70	63	79	67	76	64	100	64
HENMIQ	7	-10	5	-10	3	-8	8	-7	71	60	72	58	69	54	64	100

Table 6.5.1: Creativity-Ability Correlation Matrix

UNIQUE VARIANCES

0.688	0.068	0.522	0.311	0.833	0.285	0.801	0.427	0.119	0.369
0.117	0.298	0.091	0.374	0.340	0.431				

VARIMAX-ROTATED FACTOR MATRIX

1	TOTNUS	0.095	0.550
2	TOTNPAT	-0.034	0.965
3	TOTNSIM	0.098	0.685
4	TOTNLIN	-0.040	0.829
5	TOTUUS	0.048	0.406
6	TOTUPAT	0.018	0.845
7	TOTUSIM	0.116	0.431
8	TOTULIN	0.018	0.757
9	PSATV	0.938	-0.007
10	PSATM	0.781	0.146
11	SATV1	0.940	-0.001
12	SATM1	0.812	0.207
13	SATV2	0.953	0.034
14	SATM2	0.788	0.077
15	CTMM	0.795	0.166
16	HENMIQ	0.750	-0.079

Table 6.5.2: Creativity-Ability Data (UMLFA 2 Factor Solution)

UNIQUE VARIANCES

0.689	0.067	0.522	0.313	0.826	0.272	0.777	0.428	0.109	0.171
0.100	0.062	0.069	0.092	0.346	0.439				

VARIMAX-ROTATED FACTOR MATRIX

1	TOTNUS	0.087	0.551	0.013
2	TOTNPAT	-0.050	0.963	0.052
3	TOTNSIM	0.067	0.679	0.115
4	TOTNLIN	-0.052	0.827	0.036
5	TOTUUS	0.052	0.411	-0.052
6	TOTUPAT	0.017	0.853	-0.018
7	TOTUSIM	0.071	0.417	0.210
8	TOTULIN	0.006	0.755	0.043
9	PSATV	0.940	0.008	0.092
10	PSATM	0.688	0.117	0.584
11	SATV1	0.947	0.014	0.056
12	SATM1	0.718	0.181	0.624
13	SATV2	0.961	0.048	0.067
14	SATM2	0.689	0.042	0.657
15	CTMM	0.780	0.172	0.131
16	HENMIQ	0.740	-0.070	0.092

Table 6.5.3: Creativity-Ability Data (UMLFA 3 Factor Solution)

UNIQUE VARIANCES

0.115	0.030	0.429	0.330	0.281	0.252	0.672	0.461	0.108	0.169
0.102	0.060	0.066	0.097	0.348	0.437				

VARIMAX-ROTATED FACTOR MATRIX

1	TOTNUS	0.075	0.311	0.884	-0.004
2	TOTNPAT	-0.026	0.955	0.235	0.046
3	TOTNSIM	0.069	0.536	0.514	0.121
4	TOTNLIN	-0.031	0.798	0.179	0.038
5	TOTUUS	0.037	0.179	0.825	-0.070
6	TOTUPAT	0.039	0.841	0.198	-0.026
7	TOTUSIM	0.067	0.277	0.445	0.220
8	TOTULIN	0.026	0.717	0.150	0.047
9	PSATV	0.941	-0.022	0.027	0.077
10	PSATM	0.699	0.081	0.102	0.570
11	SATV1	0.946	-0.018	0.026	0.041
12	SATM1	0.733	0.153	0.063	0.613
13	SATV2	0.964	0.021	0.027	0.048
14	SATM2	0.701	0.025	0.033	0.640
15	CTMM	0.783	0.132	0.083	0.120
16	HENMIQ	0.736	-0.107	0.059	0.083

Table 6.5.4: Creativity-Ability Data (UMLFA 4 Factor Solution)

6.6 The NEDT Measures

In every analysis, the NEDT measures loaded high on the ability factor. No standard achievement factor was ever obtained. This will be clear when the correlation matrix of all variables is factored.

6.7 Creativity and Grades

One of the hypotheses was that the creativity dimension and the grades dimension were moderately correlated. The correlation matrix for grades and creativity variables is given in Table 6.7.1. An UMLFA of the creativity and grades correlations was performed. The results for two and three factors are given in Tables 6.7.2 and 6.7.3. The results indicate quite independent grades and creativity factors.

To provide some evidence, however, for the relationship between creativity and grades, a comprehensive 35 variable correlation matrix (Table 6.7.4) was analyzed. This matrix included the eight creativity measures, the eight ability measures used above, the NEDT measures, and nine of the grades. Several of the variables were deleted to make the correlation matrix positive definite. The factor structures for 2, 3, 4, 5, and 6 factors are given in Tables 6.7.5 through 6.7.9. The two factor solution seems to indicate a moderate degree of relationship between creativity and grades. The first factor can be interpreted as an ability factor with high grade loadings in addition. The second factor can be interpreted as the creativity factor with some moderate grade loadings. To clarify the data, consider the three factor solution. The intelligence, creativity, and grades factor are clearly distinguished. A promax transformation to simple structure would give the correlations between the factors, an indication of their interrelatedness. The factor correlations

	LABEL	1 TOTNUS	2 TOTNPAT	3 TOTNSIM	4 TOTNLIN	5 TOTUUS	6 TOTUPAT	7 TOTUSIM	8 TOTULIN	9 ENGGR9	10 ENGGR10
1	TOTNUS	100	50	62	40	80	45	45	35	9	9
2	TOTNPAT	50	100	63	80	36	86	37	70	3	20
3	TOTNSIM	62	63	100	60	46	45	76	56	9	18
4	TOTNLIN	40	80	60	100	26	59	32	81	5	16
5	TOTUUS	80	36	46	26	100	34	38	24	6	-2
6	TOTUPAT	45	86	45	59	34	100	26	61	10	22
7	TOTUSIM	45	37	76	32	38	26	100	38	3	5
8	TOTULIN	35	70	56	81	24	61	38	100	13	18
9	ENGGR9	9	3	9	5	6	10	3	13	100	70
10	ENGGR10	9	20	18	16	-2	22	5	18	70	100
11	ENGGR11	14	17	13	15	4	24	4	14	68	70
12	MATHGR9	12	14	16	15	6	19	14	17	69	64
13	MATHGR10	14	19	19	16	4	21	14	14	71	70
14	MATHGR11	15	23	20	22	6	23	17	21	62	68
15	BIOL9	16	13	20	18	7	14	9	20	80	70
16	SCGR10	14	20	19	17	10	24	15	18	59	63
17	WORGEOG	7	4	8	8	4	9	5	12	79	69
18	WORHIST	9	7	14	7	3	13	8	15	75	76
19	USHIST	10	10	11	12	4	17	5	14	65	67
20	AVER	16	22	21	20	8	25	12	20	84	83

Table 6.7.1: Creativity-Grades Correlation Matrix

		11 ENGGR11	12 MATHGR9	13 MATHGR10	14 MATHGR11	15 BIOL9	16 SCGR10	17 WORGEOG	18 WORHIST	19 USHIST	20 AVER
1	TOTNUS	14	12	14	15	16	14	7	9	10	16
2	TOTNPAT	17	14	19	23	13	20	4	7	10	22
3	TOTNSIM	13	16	19	20	20	19	8	14	11	21
4	TOTNLIN	15	15	16	22	18	17	8	7	12	20
5	TOTUUS	4	6	4	6	7	10	4	3	4	8
6	TOTUPAT	24	19	21	23	14	24	9	13	17	25
7	TOTUSIM	4	14	14	17	9	15	5	8	5	12
8	TOTULIN	14	17	14	21	20	18	12	15	14	20
9	ENGGR9	68	69	71	62	80	59	79	75	65	84
10	ENGGR10	70	64	70	68	70	63	69	76	67	83
11	ENGGR11	100	60	63	63	68	60	67	71	68	80
12	MATHGR9	60	100	75	76	73	75	68	63	55	83
13	MATHGR10	63	75	100	73	73	77	65	66	61	84
14	MATHGR11	63	76	73	100	63	74	63	69	65	85
15	BIOL9	68	73	73	63	100	68	80	79	66	86
16	SCGR10	60	75	77	74	68	100	59	63	64	81
17	WORGEOG	67	68	65	63	80	59	100	77	68	82
18	WORHIST	71	63	66	69	79	63	77	100	80	84
19	USHIST	68	55	61	65	66	64	68	80	100	78
20	AVER	80	83	84	85	86	81	82	84	78	100

Table 6.7.1 (cont'd)

UNIQUE VARIANCES

0.718	0.036	0.563	0.331	0.849	0.262	0.840		0.464	0.276	0.314
0.366	0.309	0.295	0.272	0.256	0.345	0.299		0.287	0.385	0.0

VARIMAX-ROTATED FACTOR MATRIX

1	TOTNUS	0.074	0.526
2	TOTNPAT	0.065	0.980
3	TOTNSIM	0.107	0.652
4	TOTNLIN	0.068	0.815
5	TOTUUS	0.018	0.388
6	TOTUPAT	0.110	0.852
7	TOTUSIM	0.052	0.396
8	TOTULIN	0.084	0.727
9	ENGGR9	0.851	-0.019
10	ENGGR10	0.815	0.146
11	ENGGR11	0.787	0.120
12	MATHGR9	0.825	0.100
13	MATHGR10	0.828	0.137
14	MATHGR11	0.834	0.181
15	BIOL9	0.859	0.084
16	SCGR10	0.794	0.159
17	WORGEOG	0.837	-0.009
18	WORHIST	0.844	0.022
19	USHIST	0.782	0.055
20	AVER	0.987	0.161

Table 6.7.2: Creativity-Ability Data (UMLFA 2 Factor Solution)

UNIQUE VARIANCES

0.110	0.0	0.450	0.353	0.290	0.257	0.726	0.503	0.272	0.308
0.366	0.308	0.295	0.272	0.251	0.345	0.298	0.286	0.384	0.0

VARIMAX-ROTATED FACTOR MATRIX

1	TOTNUS	0.301	0.066	0.892
2	TOTNPAT	0.970	0.069	0.231
3	TOTNSIM	0.520	0.108	0.517
4	TOTNLIN	0.778	0.075	0.191
5	TOTUUS	0.176	0.011	0.824
6	TOTUPAT	0.829	0.115	0.205
7	TOTUSIM	0.267	0.053	0.447
8	TOTULIN	0.677	0.093	0.173
9	ENGGR9	-0.043	0.850	0.060
10	ENGGR10	0.156	0.817	-0.028
11	ENGGR11	0.108	0.788	0.040
12	MATHGR9	0.078	0.826	0.052
13	MATHGR10	0.125	0.829	0.043
14	MATHGR11	0.166	0.836	0.041
15	BIOL9	0.053	0.858	0.097
16	SCGR10	0.139	0.795	0.057
17	WORGEOG	-0.024	0.836	0.036
18	WORHIST	0.005	0.844	0.039
19	USHIST	0.037	0.783	0.037
20	AVER	0.147	0.988	0.054

Table 6.7.3: Creativity-Grades Data (UMLFA 3 Factor Solution)

POSITION	LABEL	1 TOTNUS	2 TOTNPAT	3 TOTNSIM	4 TOTNLIN	5 TOTUUS	6 TOTUPAT	7 TOTUSIM	8 TOTULIN	9 PSATV	10 PSATM	11 SATV1	12 SATM1	13 SATV2	14 SATM2	15 CTMM	16 HENMIQ	17 ENG1	18 MATH1
1	TOTNUS	100	50	62	40	80	45	45	35	8	16	8	15	11	10	17	7	8	21
2	TOTNPAT	50	100	63	80	36	86	37	70	-4	11	-4	17	1	5	13	-10	-4	10
3	TOTNSIM	62	63	100	60	46	45	76	56	6	21	11	25	8	11	26	5	7	19
4	TOTNLIN	40	80	60	100	26	59	32	81	-6	5	-4	14	1	3	12	-10	0	9
5	TOTUUS	80	36	46	26	100	34	38	24	7	10	4	6	5	1	8	3	2	16
6	TOTUPAT	45	86	45	59	34	100	26	61	5	12	4	16	4	2	13	-8	0	11
7	TOTUSIM	45	37	76	32	38	26	100	38	7	21	12	27	8	18	19	8	3	18
8	TOTULIN	35	70	56	81	24	61	38	100	1	7	0	18	7	7	15	-7	2	3
9	PSATV	8	-4	6	-6	7	5	7	1	100	72	89	76	92	67	70	71	77	69
10	PSATM	16	11	21	5	10	12	21	7	72	100	67	88	70	87	63	60	68	84
11	SATV1	8	-4	11	-4	4	4	12	0	89	67	100	71	91	70	79	72	76	71
12	SATM1	15	17	25	14	6	16	27	18	76	88	71	100	73	91	67	58	65	82
13	SATV2	11	1	8	1	5	4	8	7	92	70	91	73	100	72	76	69	75	71
14	SATM2	10	5	11	3	1	2	18	7	67	87	70	91	72	100	64	54	65	82
15	CTMM	17	13	26	12	8	13	19	15	70	63	79	67	76	64	100	64	69	65
16	HENMIQ	7	-10	5	-10	3	-8	8	-7	71	60	72	58	69	54	64	100	62	56
17	ENG1	8	-4	7	0	2	0	3	2	77	68	76	65	75	65	69	62	100	67
18	MATH1	21	10	19	9	16	11	18	3	69	84	71	82	71	82	65	56	67	100
19	SOCST1	6	-9	6	-8	0	-4	11	-3	74	58	79	59	73	54	63	60	70	57
20	NATSC1	7	8	17	10	1	10	14	7	73	65	77	71	69	60	74	61	68	70
21	WORDU1	-3	-13	-4	-11	-5	-4	-2	-7	84	59	86	60	83	53	67	71	74	59
22	ENG2	14	11	18	11	12	10	8	9	65	60	69	61	68	63	69	52	73	67
23	MATH2	13	4	16	4	8	4	18	3	68	84	68	80	70	82	66	58	66	82
24	SOCST2	9	-8	11	-7	8	-2	8	-2	75	59	80	57	77	59	65	60	61	61
25	NATSC2	7	-10	10	-8	4	-10	7	-5	77	69	75	67	72	65	66	61	67	67
26	WORDU2	-1	-9	1	-7	-3	-3	3	-2	87	65	89	65	90	64	73	70	75	64
27	ENGGR9	9	3	9	5	6	10	3	13	62	51	64	52	64	52	50	43	58	62
28	ENGGR10	9	20	18	16	-2	22	5	18	54	50	62	55	56	47	54	42	48	61
29	ENGGR11	14	17	13	15	4	24	4	14	54	43	58	46	54	40	47	33	40	48
30	MATHGR9	12	14	16	15	6	19	14	17	47	59	49	57	55	59	46	30	50	70
31	MATHGR10	14	19	19	16	4	21	14	14	61	67	63	73	59	69	55	41	54	77
32	MATHGR11	15	23	20	22	6	23	17	21	47	59	49	63	58	60	47	29	36	64
33	BIOL9	16	13	20	18	7	14	9	20	63	47	64	51	66	47	56	39	56	59
34	WORGEOG	7	4	8	8	4	9	5	12	59	49	63	53	63	52	44	39	52	58
35	USHIST	10	10	11	12	4	17	5	14	56	40	58	43	59	36	46	30	38	47

Table 6.7.4: Creativity-Intelligence-Grades Correlation Matrix

POSITION	LABEL	19 SOCST1	20 NATSC1	21 WORDU1	22 ENG2	23 MATH2	24 SOCST2	25 NATSC2	26 WORDU2	27 ENGGR9	28 ENGGR10	29 ENGGR11	30 MATHGR9	31 MATHGR10	32 MATHGR11	33 BIOL9	34 WORGEOG	35 USHIST
1	TOTNUS	6	7	-3	14	13	9	7	-1	9	9	14	12	14	15	16	7	10
2	TOTNPAT	-9	8	-13	11	4	-8	-10	-9	3	20	17	10	19	23	13	4	10
3	TOTNSIM	6	17	-4	18	16	11	10	1	9	18	13	16	19	20	20	8	11
4	TOTNLIN	-8	10	-11	11	4	-7	-8	-7	5	16	15	15	16	22	18	8	12
5	TOTUUS	0	1	-5	12	8	8	4	-3	6	-2	4	6	4	6	7	4	4
6	TOTUPAT	-4	10	-4	10	4	-2	-10	-3	10	22	24	19	21	23	14	9	17
7	TOTUSIM	11	14	-2	8	18	8	7	3	3	5	4	14	14	17	9	5	5
8	TOTULIN	-3	7	-7	9	3	-2	-5	-2	13	18	14	17	14	21	20	12	14
9	PSATV	74	73	84	65	68	75	77	87	62	54	54	47	61	47	63	59	56
10	PSATM	58	65	59	60	84	59	69	65	51	50	43	59	67	59	47	49	40
11	SATV1	79	77	86	69	68	80	75	89	64	62	58	49	63	49	64	63	58
12	SATM1	59	71	60	61	80	57	67	65	52	55	46	57	73	63	51	53	43
13	SATV2	73	69	83	68	70	77	72	90	64	56	54	55	59	58	66	63	59
14	SATM2	54	60	53	63	82	59	65	64	52	47	40	59	69	60	47	52	36
15	CTMM	63	74	67	69	66	65	66	73	50	54	47	46	55	47	56	44	46
16	HENMIQ	60	61	71	52	58	60	61	70	43	42	33	30	41	29	39	39	30
17	ENG1	70	68	74	73	66	61	67	75	58	48	40	50	54	36	56	52	38
18	MATH1	57	70	59	67	82	61	67	64	62	61	48	70	77	64	59	58	47
19	SOCST1	100	70	75	59	54	68	58	75	53	42	45	39	48	34	48	49	47
20	NATSC1	70	100	71	65	66	70	71	72	54	55	45	54	64	48	64	58	49
21	WORDU1	75	71	100	60	58	71	68	91	55	46	44	37	45	30	53	53	42
22	ENG2	59	65	60	100	62	64	62	66	58	53	48	49	56	46	58	53	36
23	MATH2	54	66	58	62	100	63	68	64	60	54	47	61	70	56	55	53	41
24	SOCST2	68	70	71	64	63	100	74	75	62	56	54	49	55	48	63	64	56
25	NATSC2	58	71	68	62	68	74	100	72	54	49	45	48	59	40	60	55	43
26	WORDU2	75	72	91	66	64	75	72	100	63	53	56	43	55	44	60	61	51
27	ENGGR9	53	54	56	58	60	62	54	63	100	70	68	69	71	62	80	79	65
28	ENGGR10	62	55	56	53	54	56	49	53	70	100	70	64	70	68	70	69	67
29	ENGGR11	45	45	44	48	47	54	45	56	68	70	100	60	63	63	68	67	68
30	MATHGR9	39	54	37	49	61	49	48	43	69	64	60	100	75	76	73	68	55
31	MATHGR10	48	64	45	56	70	55	59	55	71	70	63	75	100	73	73	65	61
32	MATHGR11	34	48	30	46	56	48	40	44	62	68	63	76	73	100	63	63	65
33	BIOL9	48	64	53	58	55	63	60	60	80	70	68	73	73	63	100	80	66
34	WORGEOG	49	58	53	53	53	64	55	61	79	69	67	68	65	63	80	100	68
35	USHIST	47	49	42	36	41	56	43	51	65	67	68	55	61	65	66	68	100

Table 6.7.4 (cont'd)

UNIQUE VARIANCES

0.682	0.158	0.499	0.307	0.831	0.362	0.781	0.409	0.147	0.350
0.113	0.295	0.128	0.375	0.338	0.451	0.335	0.313	0.375	0.326
0.239	0.423	0.361	0.319	0.337	0.159	0.460	0.494	0.566	0.542
0.402	0.524	0.434	0.492	0.596					

VARIMAX-ROTATED FACTOR MATRIX

1	TOTNUS	0.089	0.557
2	TOTNPAT	-0.021	0.918
3	TOTNSIM	0.106	0.700
4	TOTNLIN	-0.016	0.832
5	TOTUUS	0.037	0.409
6	TOTUPAT	0.032	0.798
7	TOTUSIM	0.104	0.457
8	TOTULIN	0.024	0.769
9	PSATV	0.922	-0.047
10	PSATM	0.792	0.152
11	SATV1	0.941	-0.036
12	SATM1	0.811	0.218
13	SATV2	0.934	0.001
14	SATM2	0.784	0.097
15	CTMM	0.801	0.142
16	HENMIQ	0.731	-0.122
17	ENG1	0.815	-0.031
18	MATH1	0.812	0.168
19	SOCST1	0.784	-0.102
20	NATSC1	0.815	0.094
21	WORDU1	0.854	-0.177
22	ENG2	0.749	0.124
23	MATH2	0.793	0.103
24	SOCST2	0.824	-0.051
25	NATSC2	0.811	-0.075
26	WORDU2	0.910	-0.116
27	ENGGR9	0.726	0.118
28	ENGGR10	0.662	0.260
29	ENGGR11	0.619	0.225
30	MATHGR9	0.622	0.266
31	MATHGR10	0.723	0.274
32	MATHGR11	0.602	0.337
33	BIOLS	0.719	0.221
34	WORGEOG	0.702	0.126
35	USHIST	0.611	0.175

Table 6.7.5: Creativity-Grades-Intelligence (UMLFA 2 Factor Solution)

UNIQUE VARIANCES

0.692	0.060	0.528	0.317	0.832	0.278	0.810	0.439	0.123	0.362
0.088	0.309	0.110	0.375	0.323	0.407	0.329	0.281	0.347	0.330
0.158	0.429	0..51	0.318	0.345	0.118	0.311	0.361	0.459	0.238
0.222	0.278	0.304	0.340	0.488					

VARIMAX-ROTATED FACTOR MATRIX

1	TOTNUS	0.057	0.549	0.063
2	TOTNPAT	-0.086	0.963	0.081
3	TOTNSIM	0.054	0.678	0.098
4	TOTNLIN	-0.087	0.815	0.102
5	TOTUUS	0.039	0.408	-0.004
6	TOTUPAT	-0.030	0.843	0.100
7	TOTUSIM	0.073	0.425	0.065
8	TOTULIN	-0.040	0.740	0.106
9	PSATV	0.875	0.011	0.335
10	PSATM	0.617	0.131	0.490
11	SATV1	0.885	0.015	0.358
12	SATM1	0.632	0.194	0.504
13	SATV2	0.861	0.047	0.384
14	SATM2	0.592	0.058	0.521
15	CTMM	0.738	0.181	0.315
16	HENMIQ	0.751	-0.049	0.161
17	ENG1	0.753	0.004	0.321
18	MATH1	0.570	0.106	0.619
19	SOCST1	0.770	-0.045	0.240
20	NATSC1	0.699	0.106	0.412
21	WORDU1	0.898	-0.077	0.174
22	ENG2	0.628	0.130	0.399
23	MATH2	0.587	0.054	0.548
24	SOCST2	0.713	-0.047	0.414
25	NATSC2	0.705	-0.069	0.392
26	WORDU2	0.891	-0.048	0.292
27	ENGGR9	0.437	0.014	0.705
28	ENGGR10	0.367	0.170	0.690
29	ENGGR11	0.358	0.146	0.626
30	MATHGR9	0.236	0.106	0.834
31	MATHGR10	0.381	0.158	0.779
32	MATHGR11	0.234	0.193	0.794
33	BIOL9	0.428	0.118	0.706
34	WORGEOG	0.412	0.021	0.700
35	USHIST	0.357	0.087	0.614

Table 6.7.6: Creativity-Grades-Intelligence (UMLFA 3 Factor Solution)

UNIQUE VARIANCES

0.693	0.061	0.523	0.314	0.834	0.266	0.768	0.431	0.122	0.134
0.086	0.097	0.109	0.101	0.326	0.402	0.326	0.177	0.346	0.333
0.131	0.431	0.222	0.306	0.337	0.099	0.235	0.322	0.362	0.253
0.216	0.287	0.195	0.256	0.377					

VARIMAX-ROTATED FACTOR MATRIX

1	TOTNUS	0.046	0.546	0.064	0.049
2	TOTNPAT	-0.084	0.962	0.008	0.082
3	TOTNSIM	0.043	0.679	0.105	0.062
4	TOTNLIN	-0.084	0.814	-0.023	0.124
5	TOTUUS	0.031	0.406	0.017	-0.006
6	TOTUPAT	-0.021	0.845	-0.054	0.132
7	TOTUSIM	0.056	0.429	0.209	-0.027
8	TOTULIN	-0.037	0.740	-0.029	0.137
9	PSATV	0.858	0.009	0.207	0.314
10	PSATM	0.568	0.136	0.683	0.241
11	SATV1	0.870	0.011	0.168	0.358
12	SATM1	0.583	0.201	0.671	0.267
13	SATV2	0.844	0.043	0.208	0.365
14	SATM2	0.535	0.062	0.737	0.257
15	CTMM	0.718	0.179	0.234	0.266
16	HENMIQ	0.736	-0.051	0.203	0.113
17	ENG1	0.731	0.001	0.266	0.264
18	MATH1	0.521	0.107	0.603	0.421
19	SOCST1	0.760	-0.048	0.121	0.243
20	NATSC1	0.679	0.106	0.251	0.364
21	WORDU1	0.902	-0.081	0.027	0.217
22	ENG2	0.603	0.125	0.260	0.350
23	MATH2	0.538	0.055	0.605	0.347
24	SOCST2	0.697	-0.054	0.133	0.433
25	NATSC2	0.676	-0.072	0.315	0.319
26	WORDU2	0.887	-0.052	0.102	0.316
27	ENGGR9	0.417	0.006	0.131	0.758
28	ENGGR10	0.349	0.167	0.155	0.710
29	ENGGR11	0.351	0.142	0.036	0.703
30	MATHGR9	0.202	0.106	0.395	0.735
31	MATHGR10	0.342	0.158	0.449	0.664
32	MATHGR11	0.202	0.195	0.409	0.683
33	BIOL9	0.410	0.110	0.071	0.788
34	WORGEOG	0.392	0.013	0.120	0.759
35	USHIST	0.348	0.083	0.008	0.703

Table 6.7.7: Creativity-Grades-Intelligence, (UMLFA 4 Factor Solution)

UNIQUE VARIANCES

0.146	0.035	0.431	0.324	0.254	0.251	0.678	0.452	0.122	0.136
0.087	0.091	0.109	0.096	0.328	0.400	0.326	0.168	0.346	0.331
0.124	0.430	0.222	0.295	0.332	0.094	0.233	0.310	0.362	0.253
0.214	0.286	0.190	0.257	0.379					

VARIMAX-ROTATED FACTOR MATRIX

1	TOTNUS	0.046	0.351	0.024	0.058	0.851
2	TOTNPAT	-0.071	0.956	0.059	0.062	0.196
3	TOTNSIM	0.044	0.559	0.113	0.063	0.488
4	TOTNLIN	-0.075	0.798	0.025	0.110	0.144
5	TOTUUS	0.031	0.208	-0.034	0.005	0.837
6	TOTUPAT	-0.008	0.843	-0.009	0.114	0.161
7	TOTUSIM	0.053	0.304	0.206	-0.022	0.429
8	TOTULIN	-0.030	0.720	0.019	0.124	0.117
9	PSATV	0.856	-0.015	0.212	0.314	0.034
10	PSATM	0.564	0.079	0.687	0.242	0.096
11	SATV1	0.868	-0.011	0.174	0.359	0.029
12	SATM1	0.580	0.155	0.691	0.263	0.044
13	SATV2	0.843	0.021	0.215	0.364	0.034
14	SATM2	0.529	0.017	0.747	0.255	0.027
15	CTMM	0.716	0.143	0.247	0.267	0.079
16	HENMIQ	0.732	-0.086	0.199	0.117	0.061
17	ENG1	0.728	-0.028	0.268	0.266	0.035
18	MATH1	0.516	0.040	0.599	0.424	0.159
19	SOCST1	0.758	-0.069	0.122	0.245	0.024
20	NATSC1	0.677	0.092	0.265	0.363	-0.007
21	WORDU1	0.904	-0.072	0.034	0.216	-0.075
22	ENG2	0.601	0.092	0.265	0.350	0.087
23	MATH2	0.532	-0.000	0.603	0.350	0.095
24	SOCST2	0.693	-0.089	0.125	0.439	0.094
25	NATSC2	0.670	-0.113	0.307	0.324	0.076
26	WORDU2	0.888	-0.048	0.110	0.314	-0.064
27	ENGGR9	0.416	-0.003	0.129	0.759	0.039
28	ENGGR10	0.350	0.187	0.175	0.706	-0.054
29	ENGGR11	0.353	0.153	0.047	0.698	0.004
30	MATHGR9	0.200	0.085	0.397	0.734	0.049
31	MATHGR10	0.340	0.143	0.461	0.661	0.021
32	MATHGR11	0.201	0.182	0.423	0.679	0.023
33	BIOL9	0.409	0.099	0.074	0.789	0.070
34	WORGEOG	0.392	0.014	0.123	0.758	0.011
35	USHIST	0.348	0.087	0.016	0.702	0.010

Table 6.7.8: Creativity-Grades-Intelligence (UMLFA 5 Factor Solution)

UNIQUE VARIANCES

0.145	0.035	0.419	0.324	0.257	0.249	0.672	0.447	0.110	0.137
0.086	0.090	0.0	0.085	0.322	0.394	0.310	0.166	0.333	0.252
0.120	0.419	0.221	0.293	0.314	0.100	0.237	0.295	0.363	0.254
0.187	0.217	0.192	0.264	0.359					

VARIMAX-ROTATED FACTOR MATRIX

1	TOTNUS	0.044	0.349	0.044	0.059	0.852	0.025
2	TOTNPAT	-0.069	0.956	0.005	0.061	0.198	0.058
3	TOTNSIM	0.053	0.559	-0.087	0.061	0.493	0.105
4	TOTNLIN	-0.074	0.798	0.009	0.108	0.146	0.025
5	TOTUUS	0.027	0.206	0.034	0.006	0.835	-0.032
6	TOTUPAT	-0.010	0.842	-0.055	0.114	0.163	-0.008
7	TOTUSIM	0.054	0.303	-0.064	-0.022	0.432	0.205
8	TOTULIN	-0.035	0.719	0.077	0.122	0.118	0.023
9	PSATV	0.851	-0.015	0.133	0.317	0.030	0.217
10	PSATM	0.561	0.079	-0.032	0.242	0.098	0.687
11	SATV1	0.863	-0.011	0.064	0.362	0.026	0.181
12	SATM1	0.574	0.155	-0.007	0.265	0.044	0.696
13	SATV2	0.830	0.022	0.349	0.372	0.025	0.225
14	SATM2	0.515	0.015	0.079	0.257	0.026	0.759
15	CTMM	0.720	0.144	0.012	0.268	0.078	0.247
16	HENMIQ	0.735	-0.085	-0.029	0.118	0.061	0.199
17	ENG1	0.740	-0.026	-0.064	0.259	0.037	0.265
18	MATH 1	0.521	0.041	-0.039	0.423	0.160	0.595
19	SOCST1	0.764	-0.068	-0.059	0.244	0.025	0.122
20	NATSC1	0.701	0.095	-0.236	0.357	-0.004	0.253
21	WORDU1	0.906	-0.071	-0.023	0.215	-0.076	0.037
22	ENG2	0.611	0.093	-0.059	0.345	0.088	0.264
23	MATH 2	0.538	0.001	-0.025	0.347	0.096	0.599
24	SOCST2	0.694	-0.089	-0.007	0.439	0.093	0.128
25	NATSC2	0.683	-0.112	-0.089	0.319	0.078	0.302
26	WORDU2	0.878	-0.049	0.078	0.318	-0.066	0.121
27	ENGGR9	0.416	-0.003	-0.035	0.754	0.040	0.132
28	ENGGR10	0.351	0.188	-0.109	0.709	-0.051	0.173
29	ENGGR11	0.341	0.151	-0.045	0.702	0.006	0.055
30	MATHGR9	0.203	0.087	0.045	0.734	0.048	0.394
31	MATHGR10	0.344	0.144	-0.153	0.662	0.025	0.459
32	MATHGR11	0.174	0.181	0.208	0.698	0.017	0.435
33	BIOL9	0.419	0.101	-0.000	0.783	0.070	0.071
34	WORGEOG	0.390	0.014	-0.021	0.753	0.012	0.128
35	USHIST	0.334	0.086	0.121	0.712	0.006	0.022

Table 6.7.9: Creativity-Grades-Intelligence (UMLFA 6 Factor Solution)

can also be found by the new ACOVS (Analysis of Covariance Structure) approach of Jöreskog. The promax rotation gives correlations between intelligence and creativity of .005, between intelligence and grades of .457, and between grades and creativity of .247. The four factor solution shows the breakdown of the intelligence factor into verbal and mathematical components; the five factor solution shows the breakdown of the creativity factor into figural and verbal components. Further solutions show the creativity factors further dividing into Uses and Similarities factors.

These data clearly show that the creativity items define a dimension, that the creativity dimension is independent of intelligence, and that the intelligence and creativity dimensions are independently related to the grades dimension, the intelligence being more closely related which, of course, was expected.

6.8 Analysis by Regression

In addition to the analysis presented thus far, these data can also be examined using a regression technique. The existence of the three dimensions of creativity, intelligence, and school achievement has been demonstrated by the factor analysis. In the regression, eight variables will be used to define each as listed below:

Creativity	Intelligence	School Achievement
Uses-number	PSAT Verbal	English Grade 9
Patterns-number	PSAT Mathematical	English Grade 10
Similarities-number	SAT Verbal 1	English Grade 11
Lines-number	SAT Mathematical 1	Mathematics Grade 9
Uses-uniqueness	SAT Verbal 2	Mathematics Grade 10
Patterns-uniqueness	SAT Mathematical 2	Mathematics Grade 11
Similarities-uniqueness	CTMM	Biology Grade 9
Lines-uniqueness	Henmon-Nelson	Science Grade 10

All scores were standardized with a mean of zero and a variance of one in order to give equal weight to each score. Total scores were then obtained by adding the individual scores in each dimension. A set of total scores for N = 139 is given in Table 6.8.1.

Using the achievement measures as criterion measures, the intelligence and creativity measures were entered into the regression equation, first alone, then together. The scatterplots of grades and intelligence, grades and creativity, and creativity and intelligence are given in Figures 6.8.2 through 6.8.4.

The regression tables are given in Tables 6.8.5 through 6.8.8. It can be seen in Table 6.8.5 that the intelligence measures are correlated .69 with the grades, thus accounting for approximately 48 per cent of the variance in the achievement measures. The F value is obviously significant at the .001 level. Table 6.8.6 shows that the creativity measures alone are correlated .220 with the grades and account for approximately 5 per cent of the variance; the F value is significant at the .01 level. Table 6.8.7 shows that the two sets of measures together account for approximately 50 per cent of the variance in the achievement measures. The fact that the partial correlations are almost identical with the zero order correlations indicates the independence of the independent variables. Finally, a stepwise regression was included to show the significance of adding the creativity measures to the equation after the intelligence measures had already been used as an independent variable. It can be seen in Table 6.8.8 that the amount of additional variance accounted for is significant at the .05 level.

This seems to be fairly convincing evidence for the independent effect of creativity on achievement at least in this sample using these measures.

INPUT DATA ***PAGE 1 OF FILE MEANALL

POSITION	LABEL	1 CREA	2 INTELL	3 GRADES
1	L001	0.72	0.96	1.16
2	L003	-0.75	-0.82	0.51
3	L008	-0.61	-0.03	-0.73
4	L010	-0.54	-1.64	-1.91
5	L012	-0.35	-0.98	-1.10
6	L014	-0.83	0.40	0.70
7	L022	0.14	1.50	1.89
8	L024	-0.70	-1.64	-1.58
9	L025	-0.89	-1.80	-0.13
10	L026	-0.58	-1.88	-1.37
11	L027	-0.17	-1.03	0.39
12	L028	0.26	-0.63	-1.16
13	L029	0.17	-0.14	0.28
14	L032	2.80	-0.43	1.20
15	L033	1.47	-0.64	-0.43
16	L035	-0.32	-0.19	-0.55
17	L038	-0.36	-0.17	-0.41
18	L040	0.09	0.0	-0.46
19	L042	0.14	-0.09	-0.92
20	L044	-0.84	-0.54	-1.55
21	L046	-0.59	-0.63	-1.46
22	L048	-1.21	-0.69	-0.67
23	L051	1.05	0.65	0.55
24	L052	-0.44	-0.56	-0.87
25	L053	0.07	1.76	1.19
26	L055	1.75	0.17	1.44
27	L059	0.61	-1.09	-0.54
28	L068	-0.16	-0.26	0.21
29	L070	-0.86	1.64	1.46
30	L073	-0.31	-0.48	-1.54
31	L074	-0.70	-1.45	-1.97
32	L075	-0.75	1.16	1.54
33	L076	1.04	-0.65	0.59
34	L079	1.26	-0.28	0.22
35	L082	-0.70	-0.13	-0.50
36	L090	-0.36	1.65	0.82
37	L092	0.02	1.49	1.53
38	L094	1.40	-0.89	-0.12
39	L096	0.33	-0.40	-1.30
40	L097	-1.00	-0.26	-0.83
41	L098	-0.52	0.84	1.43
42	L099	-0.62	-1.14	-0.51
43	L103	-0.07	-0.78	-1.43
44	L108	1.94	-0.83	-0.81
45	L112	-0.07	1.26	0.85
46	L114	-0.91	0.80	0.89
47	L115	-0.58	-1.02	-1.26
48	L118	-0.50	-0.63	0.14
49	L120	-0.93	1.39	0.56
50	L123	0.30	0.48	-1.56

Table 6.8.1: Creativity, Intelligence, and Grades Indices (N = 139)

INPUT DATA ***PAGE 2 OF FILE MEANALL

POSITION	LABEL	1 CREA	2 INTELL	3 GRADES
51	L128	0.83	-0.32	0.53
52	L134	-0.68	0.60	0.85
53	L136	0.90	-0.48	0.22
54	L138	1.58	0.88	1.20
55	L139	-0.10	-0.36	-0.25
56	L142	-0.40	0.17	0.72
57	L143	-0.50	0.82	0.60
58	L146	-0.37	0.36	0.22
59	L154	-0.52	-0.48	-0.27
60	L155	3.50	0.88	0.42
61	L158	-0.40	-0.62	-0.92
62	L159	-0.08	0.49	0.43
63	L160	-0.72	0.49	1.18
64	L166	-1.23	-0.42	-0.62
65	L168	-0.56	-0.28	-0.04
66	L171	-0.44	-1.74	-0.28
67	L173	-0.[illegible]1	0.22	1.05
68	L177	-0.45	0.40	-0.70
69	L179	0.12	-0.22	-1.53
70	L181	-0.82	-1.42	-0.83
71	L183	0.07	0.03	-1.37
72	L186	-1.11	-0.8[illegible]	-1.19
73	L189	0.33	1.54	0.97
74	L190	-0.60	1.65	0.85
75	L191	-0.07	-0.36	0.13
76	L201	0.[illegible]3	-0.33	0.19
77	L202	-0.90	0.07	-0.84
78	L205	-0.89	0.75	0.77
79	L206	0.52	0.67	0.27
80	L207	-0.56	-1.26	-0.92
81	L215	-0.86	0.55	0.76
82	L216	0.06	0.66	0.96
83	L217	-0.27	0.80	1.28
84	L219	-1.05	0.05	-0.53
85	L222	-0.69	1.42	1.08
86	L223	0.49	0.16	-0.64
87	L226	-0.68	1.61	1.12
88	L229	0.29	-0.89	-1.41
89	L231	-0.98	0.67	-0.61
90	L232	0.36	1.03	0.44
91	L235	0.79	1.73	1.60
92	L237	-0.13	0.57	-0.39
93	L240	2.84	2.09	1.24
94	L241	-0.74	1.13	0.34
95	L242	-0.12	-2.32	0.13
96	L250	-0.68	1.74	1.21
97	L253	-0.63	0.92	1.27
98	L254	1.01	-0.65	-0.51
99	L255	0.84	-1.55	-1.79
100	L258	0.72	0.41	0.82

Table 6.8.1 (cont'd)

INPUT DATA ***PAGE 3 OF FILE MEANALL

POSITION	LABEL	1 CREA	2 INTELL	3 GRADES
101	L272	0.40	-0.70	0.06
102	L281	0.67	-0.31	-0.49
103	L282	0.13	2.03	1.68
104	L288	-0.82	-0.32	-0.39
105	L289	-0.77	-0.59	-0.01
106	L291	-0.98	-0.34	0.76
107	L292	-0.84	-1.69	-1.28
108	L293	-0.28	-1.61	-0.60
109	L295	0.62	0.24	0.62
110	L298	0.45	1.46	0.98
111	L299	-0.07	0.29	0.15
112	L300	-0.24	0.11	0.59
113	L301	-0.78	-1.58	-0.38
114	L303	-0.15	-1.51	-1.79
115	L304	-0.72	-1.84	-0.65
116	L306	-0.64	1.87	1.43
117	L308	-0.17	0.17	1.24
118	L311	-0.12	0.19	1.36
119	L314	1.32	0.24	1.09
120	L321	-0.54	0.57	-0.43
121	L322	0.27	-0.58	-0.40
122	L330	-0.67	1.66	1.27
123	L331	0.03	-0.04	-0.99
124	L338	-0.30	-1.39	-1.67
125	L345	-0.94	1.50	0.96
126	L349	0.68	-0.27	0.22
127	L350	3.00	0.0	-1.52
128	L351	-0.95	-1.80	-2.10
129	L352	3.59	-0.74	1.41
130	L353	0.10	0.27	-0.21
131	L354	3.97	1.61	1.42
132	L356	-0.95	-0.22	-1.66
133	L357	1.86	0.69	-0.11
134	L358	-0.61	0.63	-0.28
135	L360	-0.32	0.61	-0.08
136	L363	-1.10	-0.31	-1.32
137	L364	0.93	0.23	0.42
138	L374	-0.52	0.40	0.99
139	L379	0.70	-1.13	0.59

Table 6.8.1 (cont'd)

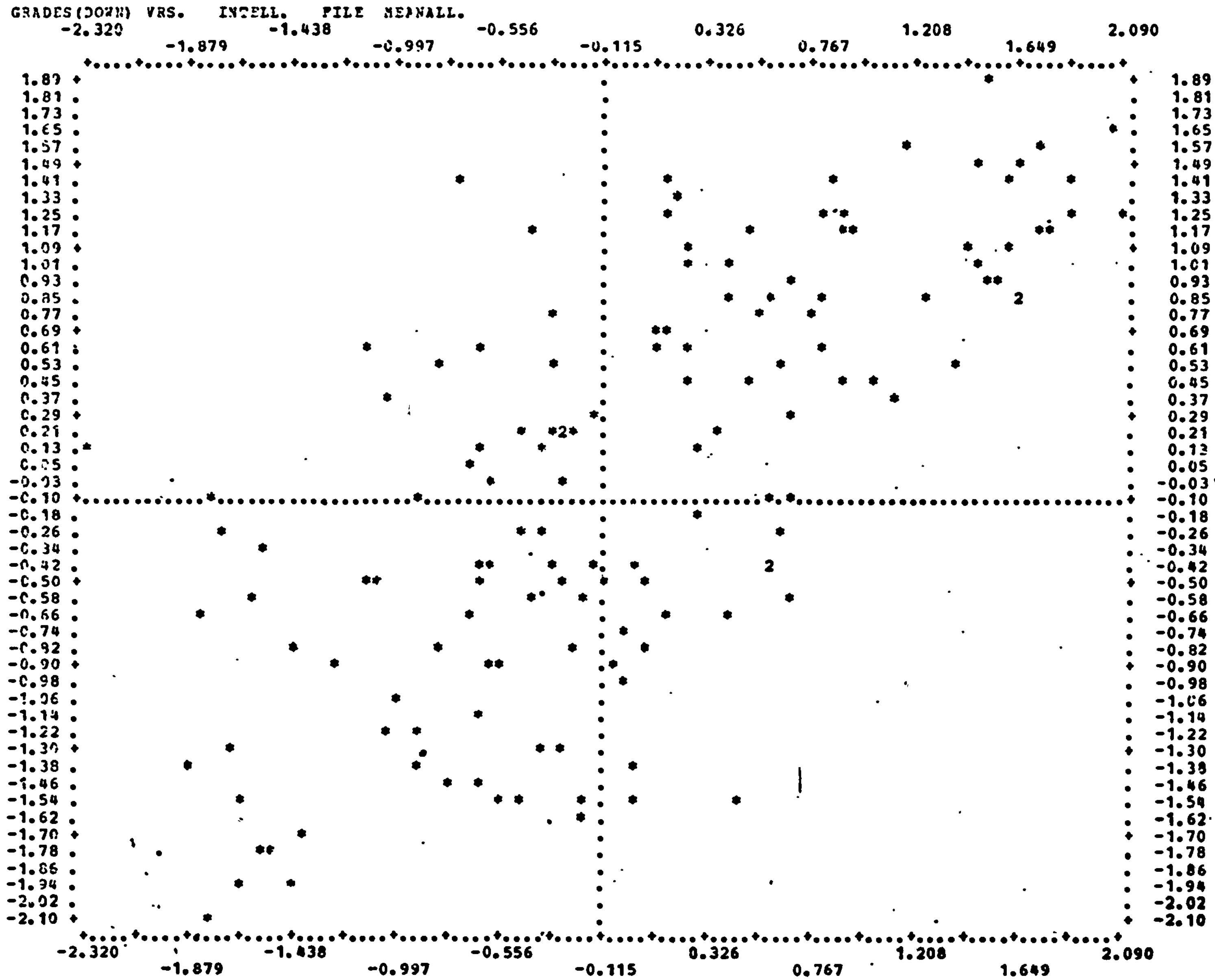

Figure 6.8.2: Regression of Grades on Intelligence

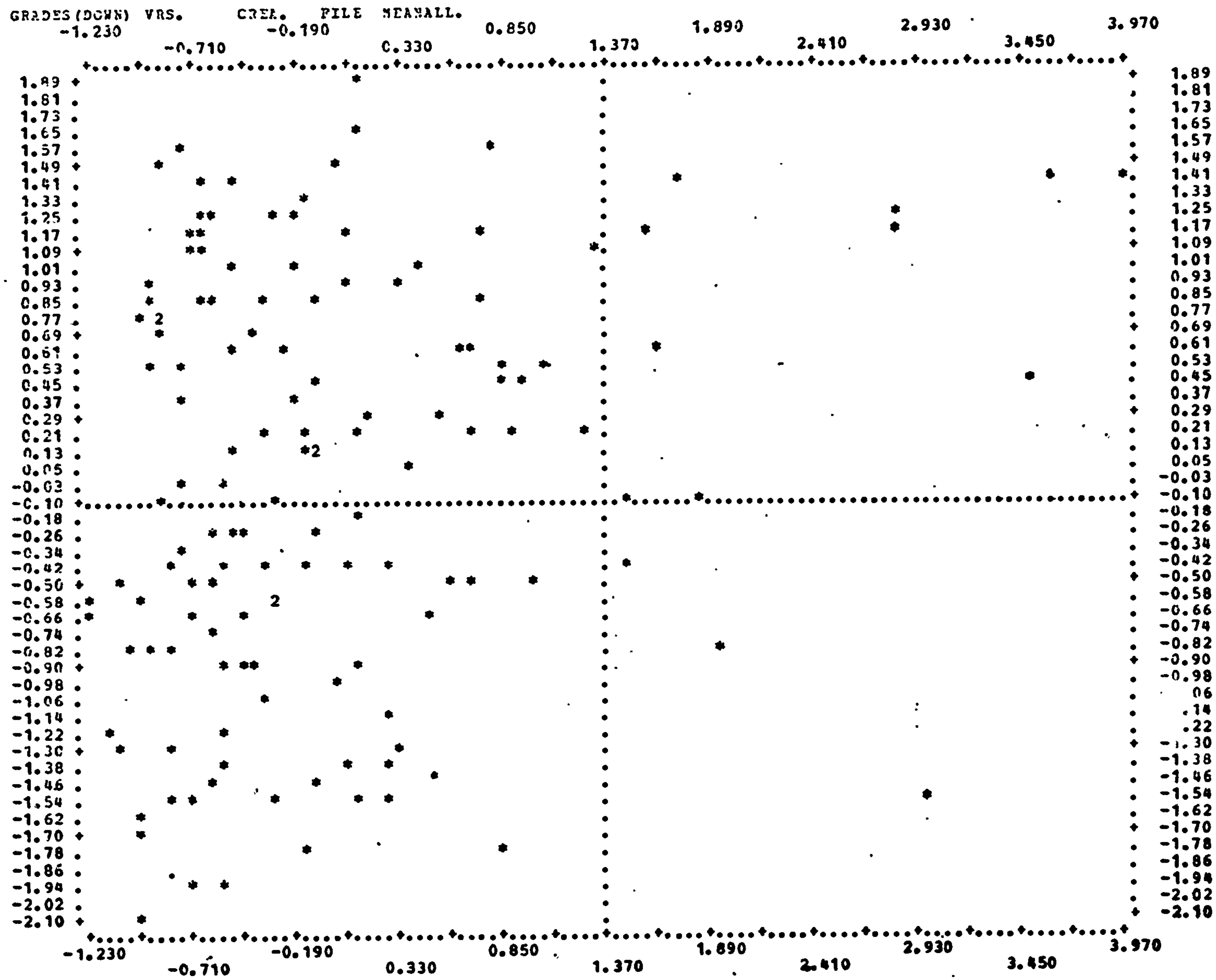

Figure 6.8.3: Regression of Grades on Creativity

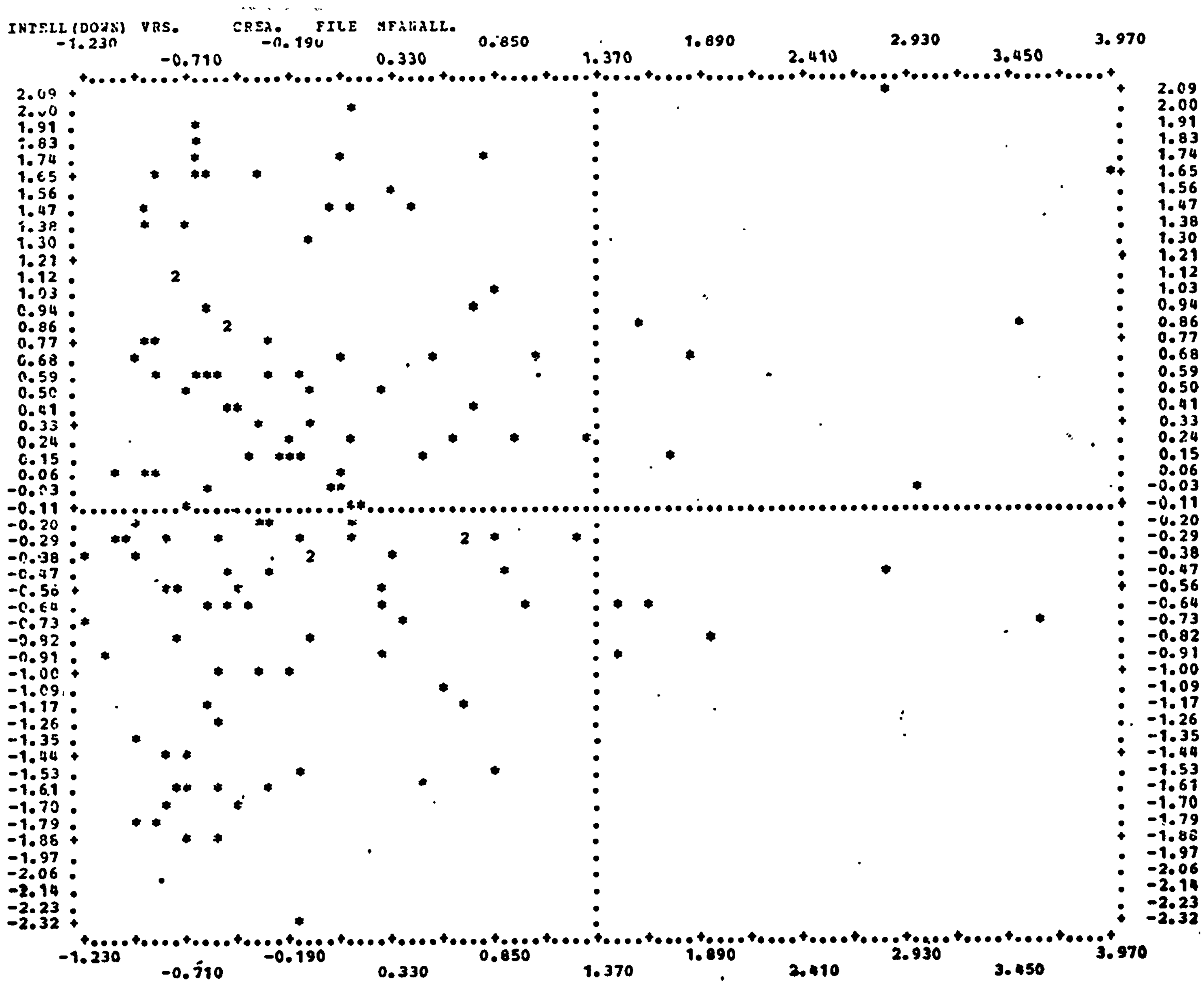

Figure 6.8.4: Regression of Creativity on Intelligence

MULTIPLE REGRESSION USING FILES CORALL AND DESALL

DEPENDENT VARIABLE IS NUMBER 3 (GRADES)

INTERCEPT IS -0.0001

MULTIPLE R SQUARE = 0.4811
MULTIPLE R = 0.6936

DETERMINANT = 0.5189

ANALYSIS OF VARIANCE FOR THE MULTIPLE LINEAR REGRESSION

SOURCE OF VARIATION	D.F.	SUM OF SQ/ 138	MEAN SQ/ 138	F VALUE
DUE TO REGRESSION............	1	0.4813	0.4813	127.01
DEVIATION ABOUT REGRESSION...	137	0.5192	0.0038	
TOTAL...	138	1.0004		

VARIABLE	LABEL	MEAN	S.D.	INTER	RAW WEIGHTS	STAND. WEIGHTS	STD. ERROR OF WTS.	T OF WEIGHTS	PARTIAL CORR
2	INTELL	-0.0001	1.0000	0.6936	0.6938	0.6936	0.0616	11.2698	0.6936
3	GRADES	-0.0002	1.0002						

Table 6.8.5: Regression of Grades on Intelligence Alone

MULTIPLE REGRESSION USING FILES CORALL AND DESALL

DEPENDENT VARIABLE IS NUMBER 3 (GRADES)

INTERCEPT IS -0.0002

MULTIPLE R SQUARE = 0.0482
MULTIPLE R = 0.2196

DETERMINANT = 0.9518

ANALYSIS OF VARIANCE FOR THE MULTIPLE LINEAR REGRESSION

SOURCE OF VARIATION	D.F.	SUM OF SQ/ 138	MEAN SQ/ 138	F VALUE
DUE TO REGRESSION............	1	0.0482	0.0482	6.94
DEVIATION ABOUT REGRESSION...	137	0.9522	0.0070	
TOTAL...	138	1.0004		

VARIABLE	LABEL	MEAN	S.D.	INTER	RAW WEIGHTS	STAND. WEIGHTS	STD. ERROR OF WTS.	T OF WEIGHTS	PARTIAL CORR
1	CREA	-0.0002	1.0005	0.2196	0.2195	0.2196	0.0833	2.6346	0.2196
3	GRADES	-0.0002	1.0002						

Table 6.8.6: Regression of Grades on Creativity Alone

MULTIPLE REGRESSION USING FILES CORALL AND DESALL

DEPENDENT VARIABLE IS NUMBER 3 (GRADES)

INTERCEPT IS -0.0001

MULTIPLE R SQUARE = 0.5005
MULTIPLE R = 0.7074

DETERMINANT = 0.4927

ANALYSIS OF VARIANCE FOR THE MULTIPLE LINEAR REGRESSION

SOURCE OF VARIATION	D.F.	SUM OF SQ/ 138	MEAN SQ/ 138	F VALUE
DUE TO REGRESSION............	2	0.5007	0.2503	68.12
DEVIATION ABOUT REGRESSION...	136	0.4998	0.0037	
TOTAL...	138	1.0004		

VARIABLE	LABEL	MEAN	S.D.	INTER	RAW WEIGHTS	STAND. WEIGHTS	STD. ERROR OF WTS.	T OF WEIGHTS	PARTIAL CORR
1	CREA	-0.0002	1.0005	0.2196	0.1401	0.1402	0.0610	2.2966	0.1932
2	INTELL	-0.0001	1.0000	0.6936	0.6773	0.6772	0.0610	11.0958	0.6893
3	GRADES	-0.0002	1.0002						

ENDS

NUMBER OF ERRORS DURING THIS RUN WAS 0

Table 6.8.7: Regression of Grades on Intelligence and Creativity Jointly

MULTIPLE REGRESSION EXAMPLE USING SCP AND REGRES SUBROUTINES 13:26:16 2/09/72 PAGE 3

THE DEPENDENT VARIABLE IS 4, THE MULTIPLE CORRELATION IS 0.1932, THE STANDARD ERROR OF ESTIMATE= 0.7121

	SUM OF SQUARES	PROPORTION OF SQUARES	N.D.F.	MEAN SQUARE	F RATIO	PROBABILITY OF LARGER F
TOTAL ABOUT ORIGIN	138.0523		139.			
UNDER NULL HYPOTHESIS	71.6467	1.0000	137.			
DUE TO HYPOTHESIS	2.6748	0.0373	1.	2.6748	5.2743	0.0232
ERROR	68.9718	0.9627	136.	0.5071		

	STANDARD REG. WEIGHT	REGRESSION WEIGHTS	STANDARD ERROR OF WT.	T STATISTICS WITH 136.D.F.	CONTRIBUTION TO R-SQ.	MEASURE OF COLLINEARITY
CONCOMITANT VARIABLES						
VAR(1)		-0.0001	0.0604	-0.0015		0.0000
VAR(3)		0.6773	0.0610	11.0954		0.0138
INDEPENDENT VARIABLES						
VAR(2)	0.1932	0.1401	0.0610	2.2966	-0.0373	0.0

Table 6.8.8: Stepwise Regression - Intelligence followed by Creativity

6.9 Conclusion

The results of this chapter confirm the hypotheses listed at the end of Chapter 5. In this sample of high school students, the Wallach and Kogan materials provide a set of measures which are coherent. The factor analysis of the correlations among these measures gives good evidence for the figural and verbal subfactors hypothesized to be components of the creativity dimension.

The creativity measures were shown to be independent of the common measures of intelligence used in this school. In addition, the creativity measures were shown to be related to school grades. Indices of creativity, intelligence, and achievement were developed. Multiple regression of school grades on intelligence and creativity confirmed this conclusion of a relationship between creativity and grades.

There are many more areas to investigate in these data than have been included in this thesis. More detailed relationships between the subfactors of creativity and specific grades seem worth examining further. The factor analyses indicate a number of worthwhile avenues of research. If such research is continued, it seems not unlikely that it will suggest reliable ways of changing the educational system into one which is much more responsive to complex human behavior.

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APPENDIX 1

TEST MATERIALS

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Division
of
Psychological Studies

August, 1969

Dear Student of Xaverian High School:

With Brother Kyrin Power's permission, I am inviting you to participate in a research study of some new educational materials. I have explained the nature of the materials to Brother Kyrin Powers. They are neither personality tests nor academic tests.

If you decide to fill out and return these materials, you will then be part of this study. Your responses will be kept strictly confidential by those involved in researching these materials. Some time during the coming school year, I will meet with you at Xaverian High School to explain to you what we are doing with these materials and to invite you to participate further in the research study.

After you have had a chance to look over the instructions and materials, decide whether or not you want to participate in this study. If you do, fill out the booklet and return it by August 31st. If you do not, simply return the booklet as is.

I hope you decide to participate in this study. I look forward to meeting you later in the year.

Sincerely yours,

Richard T. Murphy

Richard T. Murphy
Princeton University and
Educational Testing Service

RTM/lic

Enclosures

#____________

Name ____
Last First Middle

Address ____
Number Street

____
City State Zip

Birthdate ________________ Age ________________
Years Months

Directions: If you desire to participate in this study, complete the information asked for in the following pages. Use as much paper as you need. Add your own if necessary.

When you have finished, simply return the materials in the envelope provided.

Part I

On each of the following three pages will appear the name of a familiar object. We would like you to write down all the different ways you can think of in which the object might be used. Do not hesitate to write down whatever ways you can think of in which the object might be used as long as they are possible uses for the object that is named. Use both sides and any additional paper you may want.

-3-

1. a newspaper

-4-

2. an automobile tire--either the tube or the outer tire

-5-

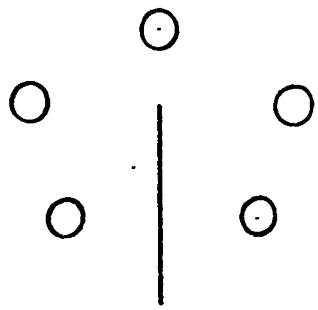
3. a shoe

Part II

On each of the following three pages will appear a pattern of a particular sort. We would like you to write down all the different things you can think of that each complete pattern might suggest. You can turn the pattern around any way you like. Do not hesitate to write down whatever things you can think of, as long as they are possible things that the pattern might suggest. Use as much paper as you please.

-7-

1.

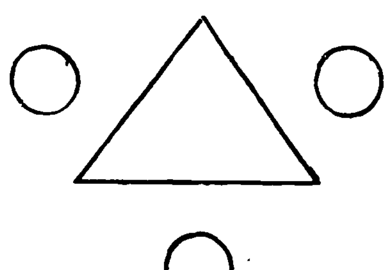


-8-

2.

-9-

3.



Part III

On each of the following three pages will appear the names of two objects. We would like you to write down all the different ways you can think of in which the two objects might be alike. Do not hesitate to write down whatever ways you can think of in which the two objects might be alike, as long as they are possible similarities between the objects. Use as much paper as you please.

-11-

1. a potato and a carrot

-12-

2. a train and a tractor

-13-

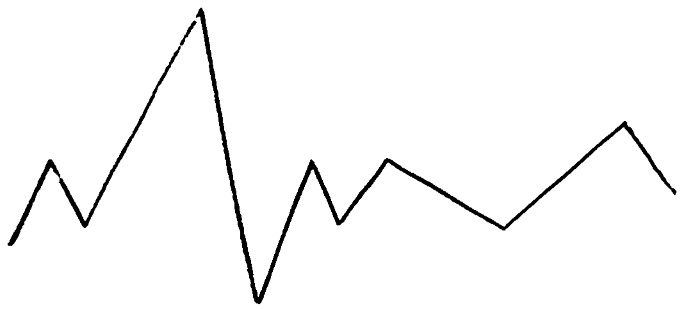
3. a grocery store and a restaurant

Part IV

On each of the following three pages will appear a continuous line of a particular sort. We would like you to write down all the different things you can think of that each complete line might suggest. You can turn the line around any way you like. Do not hesitate to write down whatever things you can think of, as long as they are possible things that the line might suggest. Use as much paper as you please.

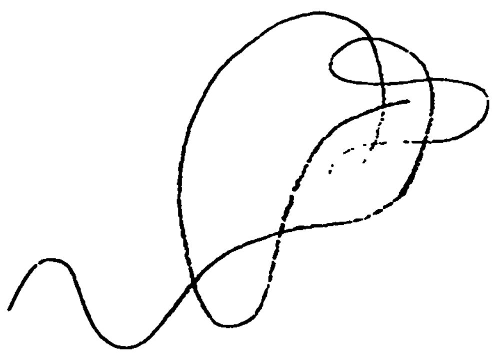
-15-

1.



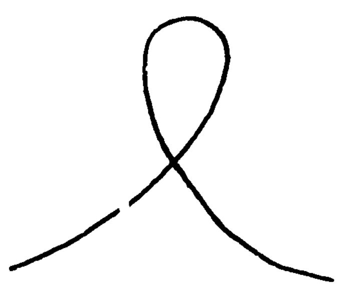
-16-

2.



-17-

3.



APPENDIX 2

CREATIVITY DATA: UMLFA TWO FACTOR SOLUTION (N=140)

CREATIVITY DATA (N=140)

UMLFA TWO FACTOR SOLUTION

UNIQUE VARIANCES											
.669	.471	.429	.039	.078	.119	.141	.107	.266	.266	.391	.138
.451	.406	.434	.071	.089	.118	.258	.308	.498	.156	.403	.110

1	.268	.509
2	.433	.584
3	.312	.688
4	.898	.393
5	.875	.396
6	.783	.517
7	.481	.792
8	.474	.817
9	.352	.781
10	.752	.410
11	.643	.442
12	.800	.471
13	.638	.376
14	.687	.350
15	.545	.519
16	.918	.294
17	.914	.275
18	.865	.367
19	.551	.662
20	.383	.738
21	.112	.700
22	.849	.350
23	.678	.370
24	.851	.408

With the scores of student number one hundred included, the factor structure is still quite clear.

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